PLASTICS TECHNOLOGY

THE MAGAZINE OF APPLIED ENGINEERING

JANUARY 1957

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JANUARY 1957 VOLUME III, NUMBER 1

ARTICLE HIGHLIGHTS and PREVIEWS 4

MARLEX 50 POLYETHYLENE—A NEW MATERIAL OF CONSTRUCTION ..... R. V. Jones, F. J. Boeke, M. W. Davidson 19
Tensile, impact, thermal and chemical properties of the material are discussed in comparison with conventional polyethylene

PHOTODEGRADATION OF PLASTIC FILMS
John Bjorksten and Risto P. Lappala 25
Data on weathering in contact with moisture show results to differ greatly from those of dry weathering.

DYNEL OVERLAYS IMPROVE PROPERTIES OF LAMINATES 27

TIME FOR SELF-APPRAISAL ..... A. Jim Fuller 28
A GUEST EDITORIAL

ALL-PLASTIC CAR INTERIOR 29

CELLULAR PLASTICS IN AIRCRAFT SEAT DESIGN ..... Stanley Lippert 30
Design Requirements are discussed, and progress to date reported for polyurethane, polyether, and PVC foams.

POLYESTER RESIN EVALUATION WITH SHORT-TIME FLEXURAL CREEP TESTS ..... A. D. Coggeshall 35
Details of a rapid, simple test which measures plasticity of a reinforced plastics laminate as a function of temperature and stress.

PLASTIC PANELS SUPERIOR TO GLASS IN LIGHT DIFFUSION 44

FEATURE DEPARTMENTS

Letters to the Editor	4	New Materials	55
"Quote . . . Unquote"	7	New Equipment	58
News in Brief	11	New Products	62
Editorial	13	New Literature	64
News of the Societies	45	Book Reviews	66
Calendar of Coming Events	72	Abstracts of Important Articles	67
News of Industry	47	Patent Digest	70
News from Abroad	51	Resins: Production and Sales	73
Names in the News	52	Current Market Prices	75
Obituary	54		

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Article

Highlights

Marlex 50 Polyethylene—A New Material of Construction. (p. 19)

Made by a low-pressure catalytic process, Marlex 50 has a high degree of crystallinity which is reflected by some important properties, including relatively high softening temperature, high tensile strength, high rigidity, low permeability to gases and liquids, and excellent chemical resistance.

•

Photodegradation of Plastic Films. (p. 25)

Weathering characteristics of films exposed to solar radiation and concurrent moisture on one side of the film are reported. Films tested were PVC, polyethylene, vinylidene, and polyester.

•

Cellular Plastics in Aircraft Seat Design. (p. 30)

Limiting factors in design and application include low product quantities and the desired properties of load deflection and vibration damping. The current status of polyurethane, polyether, and closed-cell PVC foams in this application are described in detail.

•

Polyester Resin Evaluation by Short-Time Flexural Creep Tests. (p. 35)

A simple test procedure is described which neutralizes the effect of reinforcement and directly indicates the degree to which a resin has been cured to optimum properties. Effects of cure and test variables are discussed, and test results are given.

Previews

The following five articles will be published in February:

Cutting and Trimming of Plastics with the Panel Saw. R. W. Hendrick, Hendrick Mfg. Corp., Marblehead, Mass.

Functional Selection of Plastic Materials —Part I. D. A. Dearle, plastics division manager, North & Judd Mfg. Co., New Britain, Conn.

High-Pressure Teflon Seals and Closures. H. R. Stephens, Research Chemist, Polychemicals Dept., E. I. du Pont de Nemours & Co., Wilmington, Del.

BFR Process for Fiberglass-Resin Low-Pressure Laminates. E. C. Mireau, plastics division manager, Plastushin Aviation Corp., Los Angeles, Calif.

Repairing Aluminum Castings with Metallic Resin Putty. R. E. Williams, president, Southern Casting Co., Sevierville, Tenn.

•

Letters to the Editor

Wants Extruded Profiles

Dear Sir:

Could you please assist us? We would like to have a list of companies who are extruding ½-inch round moldings in color.

James A. Norris
Acme Sign & Poster Co.
Baton Rouge, La.

(*A partial list of suppliers has been sent to Mr. Norris, and we are printing this letter to invite further suggestions from our readers for transmittal to the Inquirer.—Editor*)

• • •

Polyethylene-Styrafoam Bond

Dear Sir:

We are seeking an adhesive to make a strong, water-tight bond between polyethylene and Styrafoam. Can you suggest a source for such an adhesive?

Donald J. Smith
Monterey Park, Calif.

(*Can our readers help?—Editor*)

• • •

Wants Plastic Spheres

Dear Sir:

We would be very happy to have you put us in touch with any manufacturers or fabricators of plastic materials whom you feel might be able to supply spherical globes to an exact tolerance in sizes from 8-16 inches in diameter.

We will be interested in two types of materials; one that need not be transparent, and the second one that should be transparent or sufficiently so as to permit light to show from illumination on the inside. What we have in mind is to use these balls to make world globes.

E. A. Peterson, Gen. Mgr.,
The George F. Cram Co., Inc.
Indianapolis, Ind.

(*All replies received from our readers will be referred to Mr. Peterson.—Editor.*)

• • •

REPLIES TO INQUIRIES

Given below are two inquiries which were printed in the "Letters to the Editor" columns of recent issues with the identities of the senders withheld at their request.

Since all replies from our readers to these inquiries were sent to us for transmittal to the original inquirer, we were able to keep records of the number and nature of these replies.

We are reprinting the original inquiries and listing the companies which replied to indicate our desire to serve our readers and, through them, the plastics industry.

"We are searching for a plastic that can be sprayed, dipped, or painted on natural foam rubber to form a waterproof surface. Cure of such a coating must be either chemically at room temperature, or in dry heat at temperatures not exceeding 220° F. Can you direct us to a supplier?"

Replies have been received from: Acadia Synthetic Products, Chicago, Ill.; General Latex & Chemical Corp., Cambridge, Mass.; Montgomery Brothers, Inc., Essington, Pa.; Raybestos Division, Raybestos-Manhattan, Bridgeport, Conn.; and Thiokol Chemical Corp., Trenton, N. J.

"We are seeking a coating which can be sprayed or painted on concrete to form a waterproof surface. Cure of such a coating must be either chemically or air dried, and the cured coating must be able to take up slight amounts of movement in the concrete."

Replies have been received from: Bolta Products, Division of General Tire & Rubber Co., Lawrence, Mass.; L. H. Butcher & Co., Los Angeles, Calif.; Carbide & Carbon Chemicals Co., Silicones Division, New York, N. Y.; Gates Engineering Co., Wilmington, Del.; Hercules Powder Co., Cellulose Products Dept., Wilmington, Del.; Pennsylvania Industrial Chemical Corp., Chester, Pa.; Swift & Co., General Adhesive Products Dept., Chicago, Ill.; and Thiokol Chemical Corp., Trenton, N. J.

• • •

"Quote . . . Unquote"

Plastics in Automobiles

"Today, making automobiles without plastics is unthinkable. A typical Chrysler car has about 250 components which are made wholly or in part of plastics.

"It's no secret in the automobile industry that you want us to make wider use of plastics, particularly in such major components as body panels.

"As one who has carefully observed the almost yearly increase in the use of plastics in automobile manufacture, I would be the last to say that this is an unattainable goal. I've seen you make too much progress in a comparatively short time to be skeptical of your aspirations.

"There is one enormous barrier preventing you from attaining this goal—cost. The cost barrier is made up of two roadblocks—high initial cost, and high production costs. By present-day cost standards in the automobile industry, plastics simply are not competitive with steel for body fabrication. Every auto manufacturer is keeping a watchful eye on day-to-day developments in plastics. Moreover, they themselves are engaging in a great deal of plastics research on their own, not only in laboratory testing and evaluation, but also in creative design and engineering aimed at taking full advantage of the benefits inherent in existing plastics.

"While we are not blind to the broad promises of the future, we are today mainly concerned with substituting plastics for more traditional materials in components, and are doing so as fast as this substitution enables us to increase performance and lower costs.

"Plastics have improved automobiles in three broad areas: (1) decorative, as exemplified by the man-made fabrics and medallions; (2) mechanical, as typified by nylon gears and bushings; and (3) structural, as in our heater housing.

"But the use of plastics presents some disadvantages. One of the most persuasive arguments in favor of plastics is weight reduction. Yet we didn't save an ounce of weight with the plastic heater unit! This is an isolated example, of course. In general, substitution of plastics for steel can result in weight savings. In 1940, we found that plastic body panels, doors, and fenders were about 48% lighter than steel.

"The biggest hurdle to be overcome before plastics will enjoy wider usage in automobile interiors is cost. Generally, plastics not only cost more per pound than steel, but require more expensive production techniques for door panels."

H. E. Chesebrough, Exec. Engineer, Chrysler Corp., Detroit, Mich.

• • •

Need for Trained Personnel

"All industry, and the chemical industry in particular, is facing the serious shortage of finding trained personnel.

"We must increase the interest of high school students in science. One quarter of all American high schools offer no chemistry or physics. This situation may become worse because there is a steady decline in the number of science teachers available each year. Salary and other incentives would seem to be the first and most effective way of turning the tide.

"We should take steps, too, toward avoiding misuse of trained personnel by industry and by the armed services. We must, without infringing upon individual freedom, discover a method of channeling our talent in the directions needed.

"Specialization has become so universal in our time that we now feel urgently the need for men whose capacities can cross the narrow lines of concentrated interest. More than any specialist, we must find men whose capacities can encompass all of the areas of specialization. Today, one science overlaps another. The men we need must coordinate the efforts of specialists and be able to follow courses of development wherever they may lead."

M. G. Geiger, Exec. Vice Pres., W. R. Grace & Co. New York, New York

• • •

Plastics in Houses

"Coming, if we prognosticators are right, are far-reaching alterations in a vital segment of our lives—shelter. We visualize two different types of houses, permanent and transient. Both will make increasing use of plastics which we feel are just now beginning to come into their own as important building materials—some half-billion dollars worth went into construction last year.

"Right now, they are being widely used as interior surfaces, for floor and wall tile, in skylights, translucent roofing, electrical devices, insulation, and outdoor paints. Other outlets, catching on fast, are in pipe, hardware, luminous ceilings, and light fixtures. Visualized for the future are great synthetic domes covering both houses and garden and bringing push-button controlled climate; plastic plumbing fixtures; and molded bathrooms which can be shipped in relatively small, light-weight, 12-piece packages."

C. A. Thomas, President, Monsanto Chemical Company St. Louis, Missouri

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HEADQUARTERS

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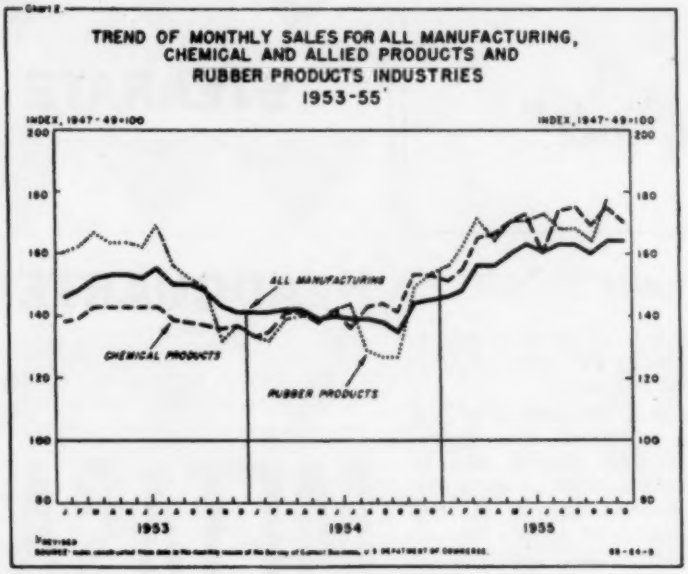

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NEWS in BRIEF

Optimistic prospects for 1957 are expected by plastics companies. In replies to an SPI questionnaire of member companies, the majority expect higher sales, profits, and wage rates during the first half of this year, and lower prices and material costs. The over-all pattern for the entire industry indicates an average company expansion of 5% over 1956; the complete range being 5-100%. Planned expansions by molders were at the lower end of this range, but greater expansions are expected by extruders and reinforced plastics firms.

Domestic production of plastic materials in 1956 reached a new high of about 4.1-billion pounds, an increase of about 10% over 1955 output, according to SPI estimates (see page 47). The Society predicts a further increase of 5% this year to a production level of 4.3-billion pounds. Last year also established plastics as a $2-billion industry for the first time. The value of plastic products in 1956 were estimated at about $2,056,450,000, and this year is expected to see another gain of about 5%.

Molders and extruders, as a group, had an increase in business volume last year of about 6%, as compared with 1955, according to sales statistics compiled by SPI. Business volume increase by thermoset molders was 10%; business by thermoplastic molders was off slightly; and moldmakers enjoyed an increase of about 16% over 1955 volume.

A call for self-appraisal by molding companies is sounded by A. J. Fuller, general manager of Rainbow Plastic (see guest editorial, page 28). He urges that molding firms build themselves by building their employees; studying their costs and checking their estimates before quoting a job or pricing a product; realistically checking their return on investment; and properly servicing their employees, customers, and suppliers.

Company developments in plastics totaled only three in number during the past month. A new firm, Dyfoam, has been formed to engage in the continuous extrusion of Dylite expandable polystyrene into sheets and slabs, using a process developed in Sweden. The company has leased a plant in New Castle, Pa., and expects to construct an additional plant later this year. Markem Plastics, custom and proprietary extruders, has entered the plastic pipe field with a full line of rigid PVC and flexible polyethylene pipe and tubing. Resin Industries, West Coast vinyl extruders and compounders, has opened an Eastern plant in Leominster, Mass.

Only three company expansions are in the news this issue. Makray Mfg. moved into a new plant in Chicago, Ill. Shell Chemical completed two new epoxy resin units at its Houston, Tex., plant. A basic scientific research institute will be built by Union Carbide near Tarrytown, N. Y.

New Materials of special interest (see pages 55-7): polyester-glass mat laminates; two releasing parchments for polyurethane foams; epoxide casting resin for high-temperature service; two high-density polyethylenes; conductive surface coating for printed circuitry; vinyl polymerization catalyst; reagent grade dioxane solvent; non-ionic dispersant for resin paints; epoxy powder for splash coats; and three chemical intermediates.

New Equipment worthy of mention (see pages 58-9, 61): die cutter for tensile specimens; automatic de-burring machines; diamond-coated saw blades; 314-ton compression and transfer molding press; two series of beta-ray thickness gages; four junior-size utility ovens; two-ounce automatic injection machine of vertical design; one-piece clamps for plastic hose; and a unit for testing gas fading of colored fabrics or sheets.

New Products to be noted (see pages 62-3); food conveyor belt made of adhesive-bonded polyester sheeting; ladder of polyester-glass sandwich construction; vulcanized fiber guides and tracks for sliding glass panels; bumper pads of canvas-covered polyurethane foam; and self-adhesive pipe markers made of vinyl-impregnated cloth.

YOUR NEW STANDARD

Escambia begins commercial production of PVC resins to bring the calendering, extrusion and molding industries a new standard for comparison.

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ESCAMBIA PVC 1225—intermediate molecular weight, particularly adapted for supported and unsupported sheeting.

ESCAMBIA PVC 1200—lowest molecular weight in this series, designed for flexible and rigid sheeting.

Your inquiries on your company letterhead are invited.

ESCAMBIA CHEMICAL
CORPORATION

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PLASTICS TECHNOLOGY

JANUARY, 1957

EDITORIAL: Report to our Readers

With this issue, PLASTICS TECHNOLOGY starts its third year of publication. We believe that this year will be of great interest to our readership, since many expansions, innovations, and other improvements are planned to begin within the next few issues. There are several changes evident in this issue, but these are only the beginning!

•

We have redesigned our contents page to provide the space necessary for the contemplated expansions in editorial content and coverage.

This issue also marks the inauguration of two new features—"Article Highlights," and "Previews." Both features have arisen from your suggestions and requests made in direct contacts with our staff, in letters and phone conversations, and in the 1956 Survey of Reader Interest.

The Highlights feature is intended to provide the handy, time-saving abstracts of our articles for which so many of you have asked. In conjunction with our regular abstracts department covering articles published in other plastics magazines throughout the world, you now have the most comprehensive review possible of plastics literature on a global basis.

Similarly, the feature on contents of our next issue will give you advance notice of coming articles that is indispensable to busy readers who are hard-pressed for time in keeping up with the constant advances of our ever-growing plastics industry.

•

The 1956 Survey of Reader Interest was the first of which is planned to be a regular annual undertaking by which we can obtain suggestions from our readers and, thus, enable us to fulfill their growing interests.

This first Survey questioned reader interest in article subjects and in our departments. Replies were received from 25.68% of our readers, studied carefully, and results tabulated to form the basis of current and future modifications in the magazine.

The percentage of replies expressing reader interest in article subjects were as follows: materials, 71.51%; equipment, 55.50%; injection molding, 48.49%; reinforced plastics, 46.25%; extrusion, 48.95%; fabricating, 37.72%; finishing, 36.73%; compression molding, 36.39%; transfer molding, 24.13%; and calendering, 22.49%.

These subject classifications are quite generalized; the individual replies, of course, were quite specific. Also, the subjects of many articles actually cut across two or more of these classifications. You can be sure that your interests will guide our selection of article subjects in coming issues.

The replies on reader interest in our department will be of equal value editorially by helping us determine which departments should be given any extra space available when making up specific issues.

•

The fruits of your suggestions are the many changes we plan this year. This is a progress report to you—other reports will follow.

Arthur M. Merrill

Editor

"fish eyes"

stalling production?

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General Tire's Chemical Division has come up with the solution to production problems and high reject rates caused by gelled particles in extrusions! The solution is VYGEN 120, a straight PVC resin especially suitable for dry blend extrusion operations.

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PLASTICS
TECHNOLOGY

Marlex 50 Polyethylene—

A New Material of Construction

Tensile, impact, thermal, and chemical properties of the material

are discussed in comparison with conventional polyethylene.

R. V. JONES, *Manager, Technical Services & Development,* F. J. BOEKE, *Manager, Sales Service Laboratory Branch, and* M. W. DAVIDSON, *Manager, Sales Service & Development Branch, Plastics Sales Division, Phillips Chemical Co., Bartlesville, Okla.*

ESSENTIALLY all plastics have been investigated as materials of construction. Many of the thermosetting and thermoplastic resins have been and are being used increasingly in a wide variety of applications. Most of these uses are of a nonload bearing nature which take advantage of the chemical inertness, light weight, electrical properties, or the fabrication economies of such plastic materials.

The thermosetting resins were first developed in the plastics industry as materials of construction. With the rapid production growth of the thermoplastic resins, interest in the structural uses of these materials has broadened considerably. However, the relatively limited strength properties of the thermoplastics have precluded their consideration in many types of structural design except where low loads are involved. This has been particularly true of conventional flexible polyethylene which, as typified by the well-known squeeze bottle plastic, has insufficient tensile and compressive strengths, and a modulus much too low to qualify for structural application.

The new, rigid polyethylenes, generally made by low-pressure catalytic processes, represent an altogether new class of thermoplastic materials having wide potentialities for development in structural uses. One of these new plastics is Marlex* 50 polyethylene (1,2,3)** which will soon be manufactured commercially by our company, employing the Phillips Polyolefin Process.

*A trademark for Phillips' family of olefin polymers.
**Numbers in parentheses refer to bibliography at end of article.

Table I. Comparative Physical Properties of Marlex 50 and Conventional Polyethylene.

	ASTM Test Method	Marlex 50 Polyethylene	Conventional Polyethylene
Melt index	D1238-52T	0.6-0.8	1.0-2.0
Density	—	0.958-0.962	0.918-0.922
Tensile strength, psi.	D412-51T	4,000-5,000	1,800-2,000
Elongation, %	D412-51T	20-30	400-600
Impact strength (Izod), ft.-lbs./in.	D256-54T*	3.0	>-16
Stiffness, psi.	D747-50	140,000	25,000
Heat distortion temperature at 66 psi., °F.	D648-45T	165-175	110-115
Brittleness temperature, °F.	D746-55T	<-185	-112
Hardness, Shore "D"	D676-49T	68-70	51-53

*¼-inch specimen.

While Marlex 50 plastic is a polymer of ethylene as is conventional flexible polyethylene, the two materials differ rather widely.

Marlex 50 polymer has a high degree of crystallinity which is reflected in a number of important properties. The material, therefore, promises to extend considerably the range of engineering uses of thermoplastics. It is the purpose of this paper to describe the properties and some of the indicated applications of Marlex 50 polyethylene that are particularly pertinent to its evaluation as a material of construction.

Physical Properties

In physical appearance, Marlex 50 polyethylene can best be described as a white, opaque, tough thermoplastic. This rigid ethylene polymer is unique in that it is essentially straight-chain in nature, with a resultant high degree of crystallinity (2). Based on X-ray diffraction, infrared, and nuclear resonance measurements, our physicists find that its crystallinity is approximately 93% at room temperature. It is this high degree of crystallinity which is responsible for many of the material's unusual physical properties. It can be shown that the relatively high softening temperature, high tensile strength, rigidity, and low permeability to gases and liquids, as well as the excellent chemical resistance, are directly related to its high crystalline-amorphous ratio.

The physical properties of Marlex 50 are shown in Table 1. From this Table, it is apparent that this thermoplastic is quite different from the conventional polyethylenes and other familiar plastics, and has improved properties which can be useful in many fields of application.

Tensile Properties

The data in Table I were obtained using methods designated as standard by the ASTM (4). While such test methods give very helpful information and are particularly valuable from the viewpoint of testing standardization, the information obtainable from such tests may be of limited value insofar as the design engineer is concerned. For example, although tensile strength and elongation are important strength criteria a full stress-strain diagram may be needed to adequately characterize a particular material under test. Furthermore, if a material is sensitive to testing speed, it may be quite important to know the behavior of such a material over a range of strain rates. Also, the effect of test temperature is always an important variable.

When we test Marlex 50 polymer at a crosshead speed of 20 inches per minute at room temperature (according to standard methods) and compare it to conventional polyethylenes, we obtain stress-strain curves as shown in Figure I. Marlex 50 resin has a much higher tangent modulus and a very low elongation compared with conventional polyethylene. If tested at 0.2 inch per minute, the modulus of both polymers decreases considerably. The comparison between the two polymers now changes in that Marlex 50 polymer has an elongation in excess of 600%.

In addition to strain rate, specimen geometry, fabrication technique, and test temperature can and do influence tensile properties. Figure 2 shows the stress-strain curves for specimens tested at a crosshead speed of 0.2 inch per minute at various temperatures.

The use of tensile data as presented above for making design calculations in applications where even moderate amounts of sustained or repetitive stress are imposed can often be misleading. For a more realistic picture of the tensile stresses which can be borne by a given stressed member, it is helpful to have long-time stress rupture or creep data. Fatigue failure in metals at stresses considerably below their tensile strengths is a familiar phenomenon. Engineers who have faced design calculations with plastic materials are acquainted with the creep phenomenon. Marlex 50 resin, being a thermoplastic, is no exception.

Creep data, to be of real value, must necessarily be based on long-time tests, preferably over a range of temperatures and environmental conditions. We have been fully aware of the necessity of such data and, as soon as possible, began a series of long-time stress rupture tests of this nature. The information to be obtained along this line is not complete as yet; however, limited data available to date are shown in Figure 3. At room temperature, sustained loads as low as one-fourth the short-time tensile strength of Marlex 50 polyethylene can cause tertiary creep failure. Ultimate

test results may indicate the necessity of limiting sustained loads to below 1,000 psi.

Impact Properties

Knowing the amount of energy that a material can absorb in impact loading is often necessary to determine the suitability of that material for a given application. Many test methods have been proposed and tried for measuring this impact property of plastics, but the method most commonly used is the Izod test, well-known to those familiar with metals testing. In the past there has been much criticism of this method because of its failure to give a true picture of the toughness of plastic materials in actual service. Such criticisms have stemmed from two reasons: (a) the fact that a very complex combination of stresses results from the cantilever-held position of the specimen during test; and (b) because the test is too severe and causes excessive rates of loading to be imposed on the specimen at the notch. We have attempted to give more extensive information on impact strength by a combination of temperature and test variables.

The impact strength of Marlex 50 polyethylene, based on the Izod test, is more or less what might be expected of a highly crystalline, high molecular weight material. Because of its relatively high molecular weight, it is only moderately sensitive to temperature in the range of −120 to +100° F. This is shown in Figure 4, where the notched Izod impact strength of the resin is compared with that of conventional polyethylene.

It is interesting to observe that the more highly branched conventional polyethylene goes through a transition in the neighborhood of 0° F. At this point, the impact strength drops sharply from greater than 16 to about one-half foot-pound per inch of notch, while Marlex 50 resin gradually decreases over this temperature range from 3-1 foot-pound per inch of notch.

If we compare the values for the unnotched-Izod impact strengths over approximately the same temperature range, as shown in Figure 5, we see that Marlex 50 polymer responds the same as conventional polyethylene, and that the two curves are practically superimposed. The effect of notch radius on the impact strength of Marlex 50 polymer is shown in Table 2.

Thermal Properties

There are many who believe, with sound reasons, that standard methods are not adequate for describing the high temperature properties of plastic materials. The test most commonly used to indicate this characteristic is the heat distortion temperature, which has sometimes been suggested as the upper use temperature for non-rigid plastics in moderately stressed applications.

It is well known, however, that there are numerous applications where only form stability (ability to retain shape at elevated temperatures) is a requirement. In such applications very low loads are encountered, as in sterilization service where fabricated items must merely maintain form stability at temperatures of 250° F. Marlex 50 polymer has form stability under such hospital sterilization conditions. Certainly, factors other than stress, such as coefficient of expansion and stresses de-

R. Vernon Jones

Paul J. Boeke

Morgan W. Davidson

R. Vernon Jones was born in Texas, and attended Texas Technological College, the University of Florida, and the University of Texas, receiving a Ph.D. in organic chemistry in 1937. He was an instructor at the University of Texas from 1933-1937, and a professor at East Texas State College from 1937-1946. After serving as an officer during the war, he joined Phillips Petroleum Co. in 1946 as group leader and, later, sectional manager in the research division. He came to Phillips Chemical in 1955 in his current position. Mr. Jones is a councilor and a past chairman of the ACS Northeast Section, and is a member of Sigma Xi, Phi Lambda Upsilon, Sigma Phi Epsilon, and Phi Kappa Tau. Mr. and Mrs. Jones have two children, and reside in Bartlesville.

Paul J. Boeke is a native of Ohio and received his education at the University of Dayton and Princeton University, from where he received an M.S. in engineering in 1949. He was an engineer at the Wright Field Air Service Command from 1942-1944; in service with the Navy from 1944-1946; research chemist for the Wright Field Air Material Command from 1946-1947; and research chemist in the engineering division of Chrysler Corp. from 1949-1952. He joined Phillips Petroleum in 1952 as group leader in the research division, and was appointed to his present position with Phillips Chemical in 1956. Mr. Boeke is a member of ACS, SPE, ASTM, and Sigma Xi. He resides currently in Bartlesville with his wife and child.

Morgan W. Davidson was born in South Dakota and attended the University of South Dakota, receiving a B.A. in chemistry in 1940. He served as a chemist for the Woods Hole Oceanographic Institute from 1941-1942, and as an Army officer from 1942-1946. He came to Phillips Petroleum in 1946 in the company's research division, and assumed his current position with Phillips Chemical in 1955. He is a member of ACS and SPE, and currently resides in Bartlesville with his wife and three children.

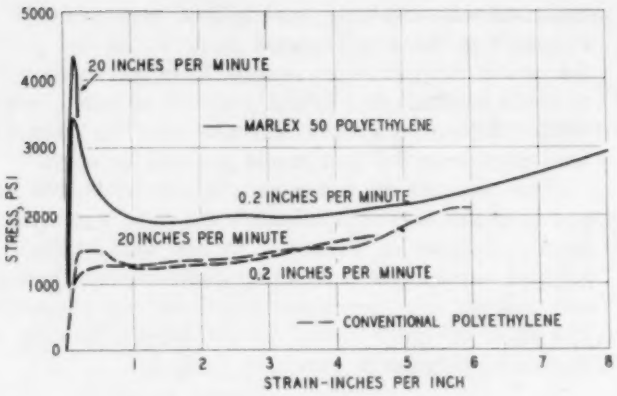


Fig. 1. Stress-strain curves for Marlex 50 and conventional polyethylene (compression molded specimens).

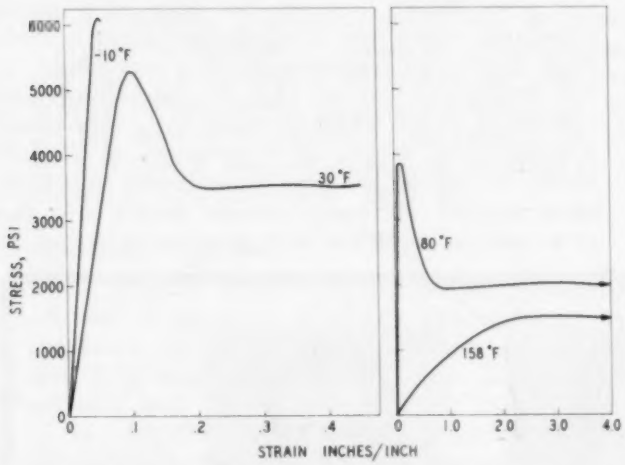


Fig. 2. Effect of temperature on stress-strain curve for Marlex 50 polymer tested at the rate of 0.02 inch/minute.

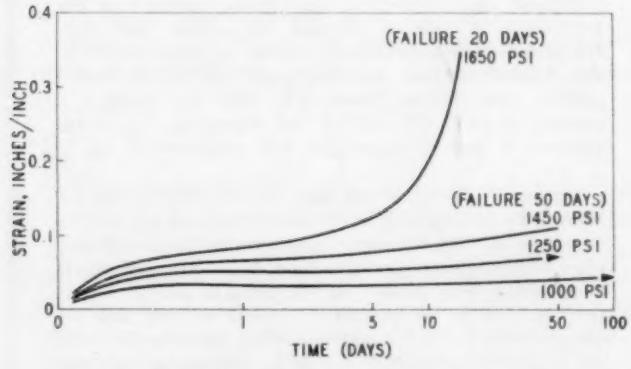


Fig. 3. Creep of Marlex 50 at 80° F. (reported for compression molded specimens).

Table 2. Effect of Notch Radius on Impact Strength of Marlex 50 at 80° F.

Radius of Notch	Impact Strength, Ft.-Lbs./Inch
Unnotched	21
Std. 0.010-inch V-notch	3.0
0.010-Inch radius notch	2.5
0.030-Inch radius notch	2.4
0.050-Inch radius notch	2.5
0.100-Inch radius notch	2.7

veloped in fabrication, are important here.

If we plot flexural deformation temperatures of Marlex 50 polymer over a range of outer fiber stresses and extrapolate this curve to zero loading (see Figure 6), we find that a flexural deformation temperature of approximately 260° F. is obtained. It is interesting to note that this temperature is quite close to the actual temperature limit of form stability which we have observed for Marlex 50 resin in actual service.

Chemical Properties

In evaluating most realistically the chemical resistance of plastics, it is desirable to test these materials in their specific chemical environments as fabricated items having the attendant fabricated-in and/or imposed stresses and tested at the particular use temperatures. Fabricated products should ideally be tested under actual service conditions.

The phenomenon of chemical resistance can be related to one or more of several factors. Most important are rates of solution and diffusion which, if sufficiently great, can result in excessive swelling and, most probably, a marked change in strength properties. One of the other important factors is chemical attack by such materials as oxidizing acids which can cause surface crazing and, usually, a decrease in strength properties. Marlex 50 resin, with its higher crystallinity, is much more resistant to such solvation and less permeable than is conventional polyethylene and most other plastics. This fact is quite evident when we compare the percentage gains in weight and tensile strengths of these two polyethylenes after immersion for 30 days in the various chemicals listed in Table 3. Even at elevated temperatures, Marlex 50 polyethylene shows good resistance to chemicals.

Under certain stressed conditions in which certain surfaces-active environments are prevalent, Marlex 50 polyethylene exhibits a tendency to undergo failure after a relatively short time interval. This type of failure, environmental stress cracking, has been experienced with metals, and is common to many plastic materials. Environmental stress cracking appears to be quite dependent on molecular chain length and stiffness (5, 6, 7, 8, 9). Marlex 50 plastic is somewhat more resistant than general-purpose, conventional polyethylene to environmental stress cracking, as shown in Table 4 which compares the F_{50} values of these two polymers in various environments.

Varying degrees of improvement in resistance to environmental stress cracking have been achieved by

copolymerization to decrease rigidity (as in the Marlex copolymers), by irradiation, and by increasing molecular weight. For pipe and certain electrical applications, this deficiency in Marlex 50 resin may be a somewhat limiting factor in these fields. The modified Marlex polymers, which excel in this property, may be desirable where exceptional resistance to environmental stress cracking is required.

It has been pointed out that all ethylene polymers have thermal limitations, and are susceptible to the action of certain chemicals. Being pure hydrocarbons, they can be destroyed by fire, a limitation which they share with many plastics, wood, and other cellulosic products. Certain valuable characteristics of Marlex 50 polyethylene are its resistance to fungi and insects, and its nonsusceptibility to rodent attack or soil corrosion. Table 5 gives the strength properties after one year of soil burial.

This polymer, like other polyethylenes, is subject to oxidation at elevated temperatures and to photo-oxidation at normal temperatures. Much work has been done to overcome these effects in polyethylenes (10). It is deemed necessary to use a thermal stabilizer to protect polyethylene from thermal degradation and, at present, it seems that well-dispersed carbon black is the most satisfactory protection against ultra-violet attack. Marlex 50 polymer can be adequately protected against thermal and photo-oxidative degradation by the addition of stabilizers, antioxidants, and carbon blacks used with conventional polyethylene.

Applications

Marlex 50 polyethylene is a valuable plastic for exploitation in many of the general fields of use now served by conventional polyethylene. More important, we are convinced that it will forge ahead into new areas of application. In addition to this, the properties of Marlex 50 polymers are such that it will compete with many other established thermoplastics such as high-impact polystyrene, nylon, saran, polyvinyl chloride, and the cellulosics.

Potential applications can best be discussed according to the products of the major types of fabrication, as follows:

MOLDINGS. Injection molding is certainly the most versatile and economical method of fabrication to obtain intricate detail in product design. We feel that injection molding will undoubtedly be one of the most promising application areas for this new polymer. Because of its fine balance of properties coupled with good processability, Marlex 50 resin is well suited for a broad range of molded applications. Its strength, inertness and thermal properties will be desirable in producing rigid, nonbreakable, heat-resistant appliance housing, protective cases, and chemical ware.

High abrasion resistance and low coefficient of friction will be particularly desirable for low-load gears and bearings, and for low-friction liners. Marlex 50 plastic has a surface gloss which offers customer appeal in automobile decorative parts, refrigerator interiors, and luggage. In some of the uses where excessive mechanical abuse is encountered, hardness may not be adequate to maintain a scratch-free surface, but it may be possible to overcome this occasional deficiency by using grained,

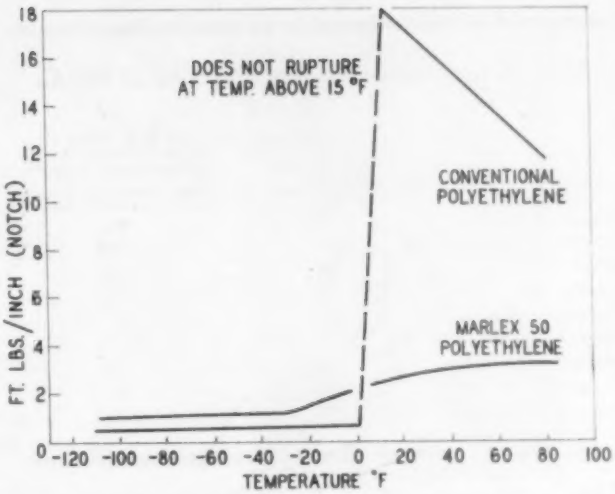


Fig. 4. Effect of temperature on Izod impact strengths of Marlex 50 and conventional polyethylene.

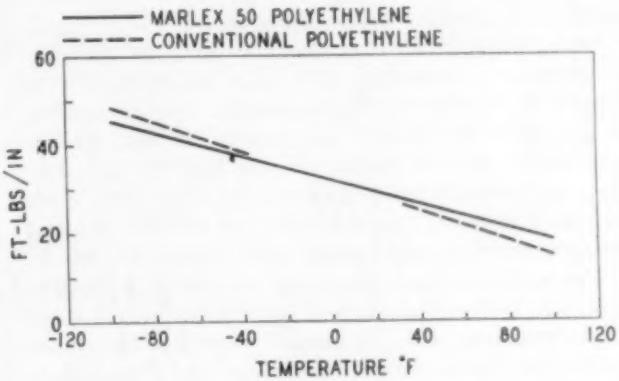


Fig. 5. Effect of temperature on unnotched Izod impact strengths of Marlex 50 and conventional polyethylene.

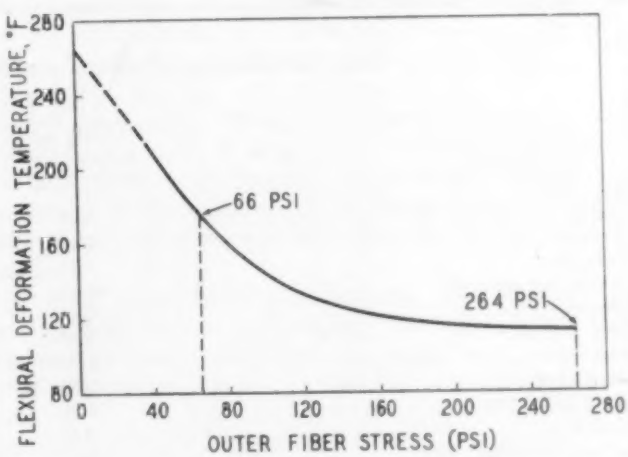


Fig. 6. Effect of outer fiber stress on flexural deformation temperature (10-mil deflection) of Marlex 50.

Table 4. Environmental Stress Cracking at 50° C.

Environment	F_{50} Values (Hrs. to 50% Failure)	
	Marlex 50 Polyethylene	Conventional Polyethylene (Molding Grade)
Igepal (CO-630)	20	0.5
DC-200 Silicone Fluid	20	0.5
Ethyl alcohol	20	0.5
Acetic acid	9	0.5
Sodium hydroxide, 5%	34	59
Ethylene glycol	40	500
Methyl ethyl ketone	34	0.8
Di-isooctyl sebacate	36	4
Soap solution, 5%	20	62

Table 5. Strengths of Marlex 50 Polyethylene in Soil Burial Tests (Injection Molded Specimens).

Burial Time, Mos.	Tensile Strength, Psi.	Elongation, %
0 (Control)	5,400	30
6	5,700	27
12	5,700	27

mottled, or wrinkled surface finishes.

FILM. Film, which amounted to 37% of the total polyethylene consumed in 1955 (11), can be made from Marlex 50 resin by current techniques. The outstanding properties which this new resin has in this field are low permeability to water vapor, stiffness, high strength, nonblocking tendency, and resistance to heat. Film from this resin does not become tacky up to 260° F., and does not embrittle substantially down to below –186° F.

This greatly extends the range for plastic packaging materials. Stiffness and slip characteristics are of value in overwrap uses, while its thermal properties will permit sterilizable pharmaceutical packages and "cooked-in-place" packages for various foods. Its high strength is desirable for the rugged service encountered in construction and irrigation uses, pond linings, and for temporary weather shelters. For applications where very low permeability is essential, such as in moisture barriers for foundations and walls and protective tapes, this resin will have definite advantages.

Conventionally extruded Marlex 50 polyethylene film may have insufficient clarity and impact-burst strength for some packaging uses. Recent laboratory extrusion work has yielded film with burst strength and clarity comparable to conventional polyethylene film quality. Development now in progress is expected to lead to commercially feasible extrusion methods.

SHEET. Marlex 50 polyethylene can be extruded and calendered into sheet in a wide range of thicknesses. With the strength, thermal, and chemical properties mentioned previously, along with its machinability and weldability, this material can be used for corrosion-resistant ducts, hoods, vents, tank linings, and sheathing. Good post-forming qualities make it adaptable to general fabrication and packaging. Plain or embossed, it has potentialities for decorative covering and paneling where its translucent nature creates pleasing indirect-lighting effects.

PIPE AND TUBING. Pipe and tubing may be fabricated of Marlex 50 by conventional extrusion methods, and may be used for low-stress applications where high softening point and chemical inertness are desirable. Before widespread use of such pipe and tubing in other applications, it will be necessary to collect more data regarding its long-time performance.

FOAMS. A most interesting form of this polymer is the foamed material which can be applied to wire or fabricated into sheets and rods. During the course of development work with this foam, it has been possible to produce low-density products with good strength properties which can be used as moisture-, chemical-, and fungus-resistant insulating material and acoustical paneling.

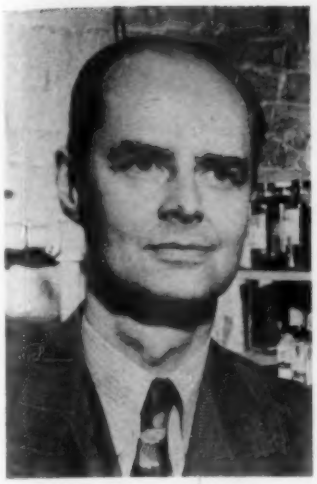
COATINGS. Coatings applied by either sprayed or fluidized techniques, particularly on metals, are a valuable means of combatting corrosion in many familiar applications.

OTHER APPLICATIONS. Marlex 50 polyethylene is under development in other fields of application, such as in wire and cable, coated paper and fabric, bottles and jars, fibers and fabrics, and reinforced rubber products. The foregoing description is intended to facilitate familiarity with this new plastic material. Undoubtedly,

(Continued on page 34)

Table 3. Chemical Resistance after 30 Days Immersion at 80° F.

Chemical	% Weight Change		Tensile Strength, psi.	
	Marlex 50 Polyethylene	Conventional Polyethylene	Marlex 50 Polyethylene	Conventional Polyethylene
(Control)	—	—	4,975	1,745
Acetic acid, glacial	0.73	0.86	4,740	1,650
Acetone	0.66	1.26	4,410	1,620
Brake fluid	0.19	0.85	4,850	1,780
Carbon tetrachloride	14.20	35.90	4,210	1,390
Ethanol	0.14	0.20	4,160	1,485
Ethyl acetate	2.30	3.07	4,670	1,630
Gasoline	6.00	12.90	4,210	1,430
Lubricating oil	0.60	3.40	4,850	1,680
Nitric acid, 70%	0.26	0.33	4,890	1,690
Oleic acid	0.70	1.57	4,770	1,660
Sodium hydroxide, 50%	Nil	Nil	4,724	1,672
Sulfuric acid, conc.	0.01	0.01	4,185	1,662



JOHAN BJORKSTEN, *President*
and
RISTO P. LAPPALA, *Research Chemist,*
Bjorksten Research Laboratories for Industry, Inc., Madison, Wis.

Photodegradation of Plastic Films

Data on weathering in contact with moisture show results to differ greatly from those of dry weathering.

WHILE considerable information is available on the behavior of plastics in general, it is surprising how little information has been collected or is commercially available on the weathering characteristics of transparent plastic films.

In the course of an investigation* of solar stills for distilling saline water on a substantial scale, it became necessary to obtain additional information on the permanence of plastic films when exposed to weathering and concurrent moisture. In the course of this work, it became apparent that weathering characteristics, particularly on exposure to solar radiation, are altogether different in films where one surface is exposed to moisture than in films where water vapor is substantially absent (see Figure 1).

Inasmuch as this fact appeared to be extremely striking, it seemed pertinent to publish some applicable data.

Test Method

The testing method employed was as follows: Two or three shovelfuls of wet sand were placed in a 15-gallon drum whose top had been cut out. The film to be tested was stretched, with only moderate tension, over the top of the open drum, and fastened in place by either replacing the drum top (with the entire center cut out) or by means of a spring fitting snugly around the top of the drum (see Figure 2). The test drums and films were oriented to face south at an angle of about 15° from the horizontal at Del Ray Beach, Florida, about one-half mile from the ocean.

During the sunlight hours, moisture is constantly evaporated from the wet sand, which maintains a temperature of about 135° F. This evaporated moisture is condensed on the inner surface of the film; the condensate runs back down into the sand, and the cycle is repeated.

The films tested in this preliminary investigation were polyvinyl chloride, polyethylene, polyester, polyvinylidene chloride, aluminized polyester, and pigmented polyethylene. Of course, the last two films are

*Under contract with the Office of Saline Water, U. S. Department of the Interior.
Based on a paper presented before the Division of Paint, Plastics and Printing Ink Chemistry, American Chemical Society, Atlantic City,, N. J., Sept. 17, 1956.

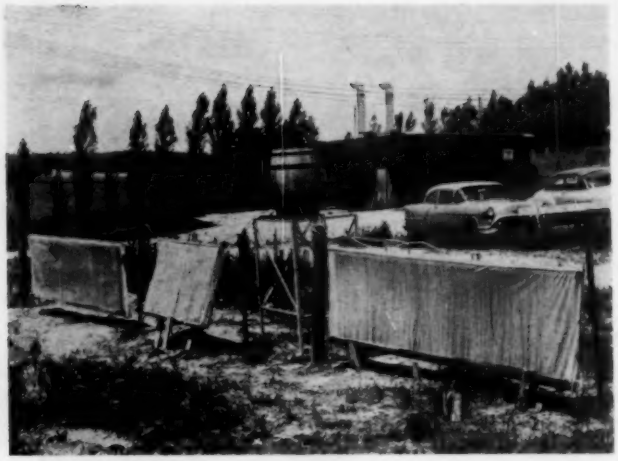


Fig. 1. Solar still, showing moisture condensation on inner surfaces of plastic films.

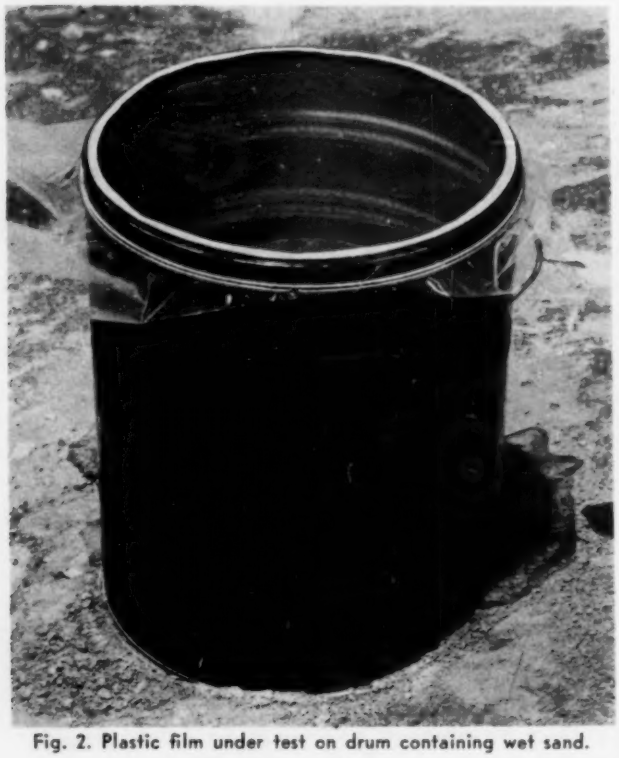


Fig. 2. Plastic film under test on drum containing wet sand.

Fig. 3. PVC film after three months test in Florida.

Fig. 4. 0.010-Inch PVC film after six months exposure shows radial cracks from center of film.

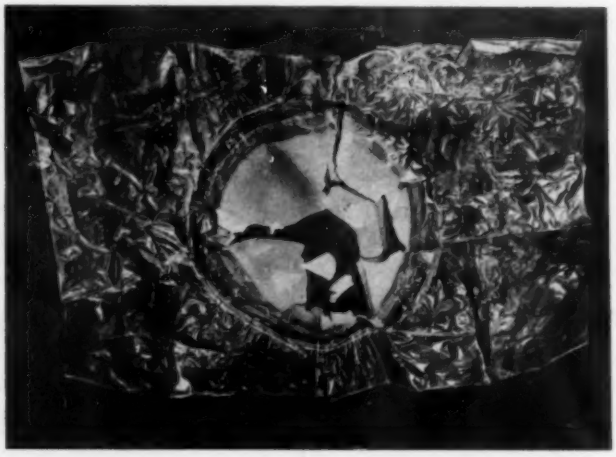


Fig. 5. 0.005-Inch PVC film after six months exposure. Portion exposed to moisture on one surface is completely embrittled.

Fig. 6. Double sheet of polyvinylidene chloride film after six months exposure. One corner is folded back to show bottom layer, which is still clear and flexible. Upper layer has discolored, but still is flexible. Neither layer shows any cracking.

Table 1. Tensile Strengths of Film Test Strips After Six Months Exposure. (Strips one-inch wide. Tensile strengths in pounds.)

Film Material	Before Exposure	After Exposure	
		Without Moisture	With Moisture
Polyvinyl chloride	20	2	0
	25	10	5
	35	20	0
Polyethylene	5	0	0
Polyvinylidene chloride	25	10	10
Polyester	45	0	0

not transparent, but were used as controls. Other films, such as cellulose acetate and cellulose acetate butyrate, had been tested previously and found to have good weathering properties when used in thick films, such as are used for outdoor advertising displays, etc.

Test Results

Results of the current test are apparent from the data given in Table 1. Visual evidence of test results is given by Figures 3-6. It can be seen that the presence of moisture during weathering has a profound influence on the weathering characteristics, and that weathering data on films taken on dry films are meaningless when the use conditions entail moisture or contact with an aqueous liquid against one side of the film.

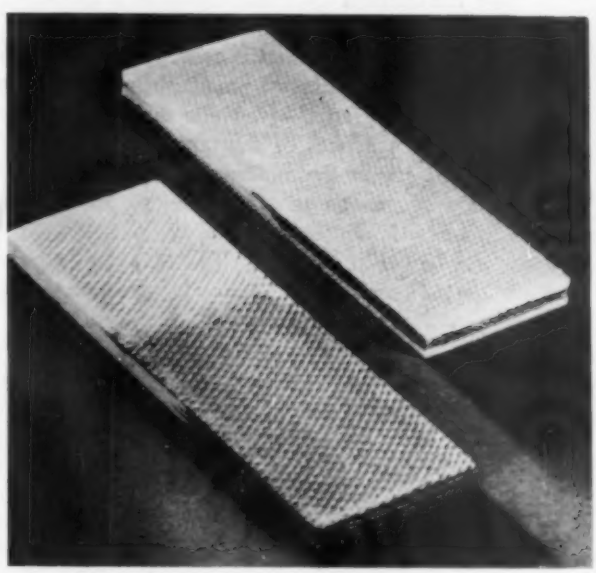
Aluminized polyester film, as well as clear polyester film, were fastened with an adhesive to a non-flexible material such as plywood or masonite so that the film could not flutter. These films were unaffected by exposure to the test conditions for a period of more than one year.

Samples of polyethylene film pigmented with a high percentage of carbon black were unaffected over a period of a year when exposed to direct sunshine on one side of the film and moisture on the other side.

There appears to be an induction period in the process of photodegradation. With the exception of polyethylene and polyester, the films appear to be unaffected or only slightly affected for the first four months, and then to be very rapidly affected to the point of breakdown in the next two months.

In view of the findings thus far, it appears that additional work should be conducted to determine whether or not water-soluble materials have been leached out of the films exposed to sunlight and moisture, and whether the mechanism of accelerated degradation is due to the presence of moisture. —The End

Dynel Overlays Improve Properties of Laminates



Glass-polyester laminate chips after immersion in 10% HCl at 90° C. for six days: chip (right) was protected with a Dynel overlay; unprotected chip (left) shows deterioration.

A method of improving the resistance of low-pressure, glass-reinforced laminates to chemicals and abrasion has been announced by Carbide & Carbon Chemicals Co., New York, N. Y. The process utilizes an overlay of Dynel fabric on either or both sides of the laminate.

A copolymer of vinyl chloride and acrylonitrile, Dynel is easily wetted by polyesters, phenolics, and epoxies, regardless of their viscosity. A fabric weighing six ounces per square yard is generally recommended for overlay work. Woven fabrics are usually preferred for articles which would be subjected to tugging and pulling; non-woven fabrics are used to impart a smooth, extremely dense surface.

Dynel is said to hold sufficient resin on its surface to eliminate the need for gel-coats, so that application and mold curing time is halved. Dynel overlays also tend to minimize resin shrinkage during mold cure, a volume loss which might otherwise reach 10%.

A fibrous glass-reinforced polyester laminate, used as a stack and exhaust hood at Wallingford Steel Co., has successfully withstood the corrosive action of hydrofluoric and nitric acid fumes for more than two years as a result of its Dynel surface veil. The installation was made by the Pla-Tank division of Haveg Industries, Inc.

—The End

Guest Editorial

Time for Self-Appraisal

A. JIM FULLER, *General Manager*

Rainbow Plastic, Ltd.

Toronto, Ont., Canada

IN the October 1956 issue, George S. Nalle, Jr., wrote a Guest Editorial that was a very commendable and frank constructive criticism of the evils of government stifling of small business through wicked tax programs. Mr. Nalle then went on to criticize the practices of the large chemical companies who supply the molding industry, he offered a timely suggestion that all molders insist on a 10% cash discount on all material, even though it may necessitate a raise in price. I heartily endorse this idea as a definite help to the legitimate molders who pay their bills on time.

However, Mr. Nalle was pointing the finger at factors outside our own industry. Is it not time we all sat down, individually, to do some serious soul-searching and give ourselves a careful self-appraisal? Let us turn now to what we can do to help ourselves.

Here are some of the questions we might ask ourselves:

(1) Are we properly organized? Do we have a well oiled machine of competent people, or are we rolling along on the geared up drive of a single man? Is it not the moral and business responsibility of owners and top executives to build people as well as profits? Of course, bigger and better profits are a very probable result of the building of people.

(2) Do we know our costs? Do we know our costs in relation to our competitors?

(3) Are we gambling unjustifiably about our return on investment?

(4) Are we paying enough attention to that all-important aspect of our own or any business, service, or do we think our customers are unreasonable and too demanding?

What kind of answers do you get when you ask yourself these questions? Other industries have found the answers, and have profited immensely. Why shouldn't we?

Let us examine the four questions and their implications:

ORGANIZATION. I have suggested that we appraise ourselves firstly from this standpoint because I feel that a sound plan of organization is the main basis for the successful operation of any company, large or small. Some 75-80% of the problems brought to consulting management engineers are found to emanate from defects in the organizational structure of the customers.

We all know of companies having one or even many so-called "hot-shots" that fall far short of the expectations and results they should achieve. On the other hand, there are concerns with not a single "fire-ball" that attain success beyond all expectations. Other things being equal, the difference is in proper organization!

We might all do well to try to practice the following methods of creating a sound organization and a smoothly functioning team: (a) Define the basic objectives of our enterprise; (b) Clearly define our organizational structure and the responsibilities of the jobs within that structure; (c) Eliminate overlapping authority; (d) Respect our lines of authority; (e) Give our key people the authority to accomplish the jobs for which we make them responsible; (f) Let these key people make some mistakes and gain experience within

the scope of their responsibilities (maybe what were mistakes yesterday may be wise moves today); and (g) Give our key personnel the opportunity to realize their full potential. In the long run, this practice will benefit everyone.

There are many specific and practical ways of carrying out these methods, but rather than go into them here, I would merely suggest that top executives in many proven firms are always willing to offer this type of specific experience. Once we realize the need, it is comparatively easy to find the particular means to suit our own peculiarities!

COSTS. We all know of the wide discrepancies in quotations on custom work, and the somewhat ridiculous pricing of many proprietary items. Let us be sure we know what our costs are on material content, labor, factory overhead, administration, selling, advertising, and promotion. In addition, many of us overlook or forget the hidden costs. Let us review our costing and estimating systems, and have another look at our overheads and material losses.

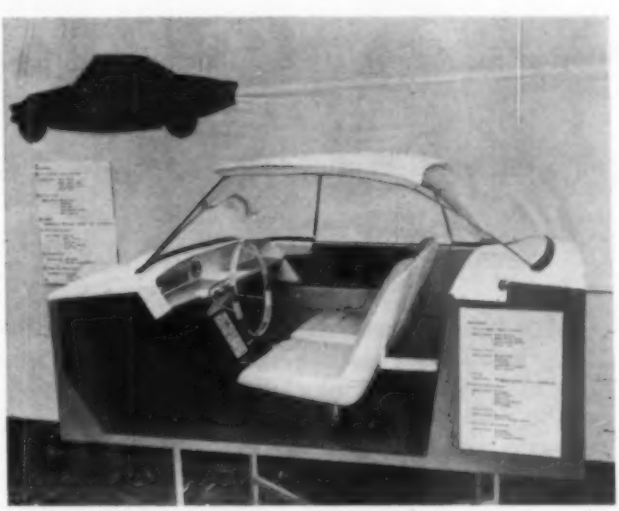
RETURN ON INVESTMENT. Many of us have a tendency to say "I have a million dollars invested, and my return is ridiculously low." Before you grumble too much, just be sure you do have the investment you think. Do you have company money invested in outside stocks or bonds? Are you carrying a bank loan that is out of all proportion to the size of your business (due to prior mismanagement or other cause)?

SERVICE. It has been said that "Service is conduct contributing to the advantage of another." In my opinion, proprietary molders should give service by promoting, pricing, and selling their products in such a manner as to increase sales and profits for their customers. Custom molders should give service by (a) educating their accounts to the fullest extent possible about tooling, molding, materials, and methods; and by (b) contributing as much "know-how" as possible at the advance engineering stage of product development. All molders should give service not only to customers, but to suppliers and employees by using "Conduct contributing to their advantage."

Summarizing briefly, let us all do some careful self-appraisal; build ourselves by building people; study our costs and double check our estimates before quoting a job or pricing a product; look honestly at our return on investment; and service our employees, customers, and suppliers. By doing so, I honestly believe that we will not only produce bigger profits, but we will also fulfill a most important moral obligation.

—THE END

All-Plastic Car Interior



Model car interior features many new uses for plastics.

A three-quarter scale, experimental automobile interior, utilizing plastics in a number of novel applications, has been designed and built by students at Pratt Institute. The project, sponsored by Monsanto Chemical Co., was intended to acquaint young designers with the properties and capabilities of plastics.

Bucket seats were molded in one piece from fibrous glass-reinforced polyester resins, upholstered with urethane foam, and coated with sprayed-on vinyl. High-impact styrene was used to form the one-piece door liner; the arm rests being cushioned with urethane foam. Foam was also used between the styrene head liner and the roof, affording both acoustical and thermal insulation.

Polyesters, vinyls, and styrene, all cushioned with urethane foam, were used as instrument panels. Other features include a flexible, roll-out plastic map; a one-piece, behind-the-seat deck shelf; and a vinyl floor covering which can be sprayed or laminated to the car body. All parts were designed for both functional and aesthetic reasons.

—THE END

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Cellular Plastics in Aircraft Seat Design

Design requirements are discussed, and progress to date reported for polyurethane, polyether, and PVC foams.

MOST of the contacts of a seat designer with the plastic industry are through sales representatives who bring samples of new materials to be examined from time to time. It is possible for engineering personnel to discuss with these representatives some of the problems of aircraft seat design which are of interest to the manufacturer of cushioning materials. Rarely is there an opportunity, however, for talking directly with those persons who are responsible for the formulation of new products.

Many of the technical people who have helped bring out new products with unique properties may wonder why dramatic use is not being made of these materials in aircraft seat design, so it may be of value to discuss some of the problems peculiar to the aircraft industry before going into a description of a few of the products.

It may not be readily apparent but there are a number of quite subtle considerations which enter in the design of an aircraft seat. At present, there is nothing in the literature which covers these considerations in great detail. There is, however, a considerable body of knowledge held by various designers who have worked in the field for years, and reasonable methods do exist for arriving at key decisions in the development of a new seat.

There remains some art, but no magic, in getting a good solution to a well-stated problem. However, excellence in all phases of seat design is useless if the quality of the cushion materials is not controlled. Aircraft double seats have a price range of about $500-800. The reason for this range is the low production quantity and the rigid requirements of high strength and low weight, coupled with the need for comfort and good service life.

The Quantity Problem

The problem of quantity is more serious than one might at first realize. In the DC-6 airplane, for example, a seat was designed by Douglas to attach to the side wall in order to achieve maximum seat width and

adequate strength, while preserving underseat clearances. With the increase in passenger traffic and the wide-scale introduction of coach type seating, such a seat proved too inflexible a design for an operator who must carry both luxury and coach type seating or coach type seating alone. The provision of flexibility for modern transports requires that seats be on tracks and suited to a variety of fore and aft space patterns. It was necessary, therefore, for Douglas to develop a new seat substantially the same in comfort as an existing one but with the trackable feature.

Because short-haul airplanes are not as critical in seating requirements as are long-haul planes, both the operator's route as well as the class of travel have an influence on the degree of comfort desired. A further complication arises from the need for overwater operators and some domestic operators to obtain a berthable seat.

A consideration of just one related series, the DC-6, DC-6B, and C-118 airplanes, reveals the nature of the cushion procurement problem. Between 1947 and 1951, a total of 170 DC-6 airplanes were delivered, of which 30 had sleeper seats only, 40 had both sleeper and dayplane seats, and 100 had dayplane seats only. From 1951 to the present, 250 DC-6B's have been delivered, of which 150 were furnished with Douglas Dayplane Seats, and 100 were furnished with seats manufactured by four other companies. From 1951 to 1955, a total of 167 C-118A airplanes were furnished to the military services. All of the seats were manufactured by another company.

Since only about 26 double seats are required per airplane, it is readily apparent that aircraft requirements do not represent a high quantity and that quality should be stressed. This has a much more direct implication for the producers of foam materials than they may realize, because it means that the aircraft industry cannot place large orders in advance for a particular set of cushions. It also means that the manufacturer of cushion materials who can achieve quality control in dimensions, weight, spring properties (i.e., load vs. deflection), and damping properties of the materials has a distinct advantage over others.

Latex rubber foam is the only material that Douglas has used in quantity in its aircraft seats recently, but there exists no proper industry-wide specification which controls the foam properties in a manner suitable for good seat design. Latex foam as a seat cushion material is still in its early stages of commercial development. If, after all these years of utilization, quality control has not been achieved, the question that immediately comes to mind is how long will it take for the establishment of adequate specifications for the foam plastics currently being manufactured? A seat manufacturer cannot risk a bad passenger reaction or a poor service life resulting from use of an unknown and uninspected material.

Properties Desired

It is appropriate now to examine the physical properties required in an aircraft seat cushion, and the reasons for these requirements. From informal test and from a long experience in the manufacture of seats

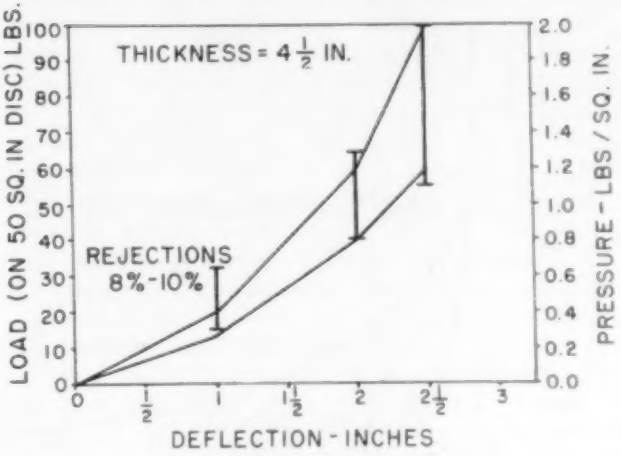

Fig. 1. Load-deflection curves used for production control on latex foam cushions. Upper and lower curves define limits of acceptability. Vertical bars show ranges of values obtained on 358 cushions tested for load-deflection.

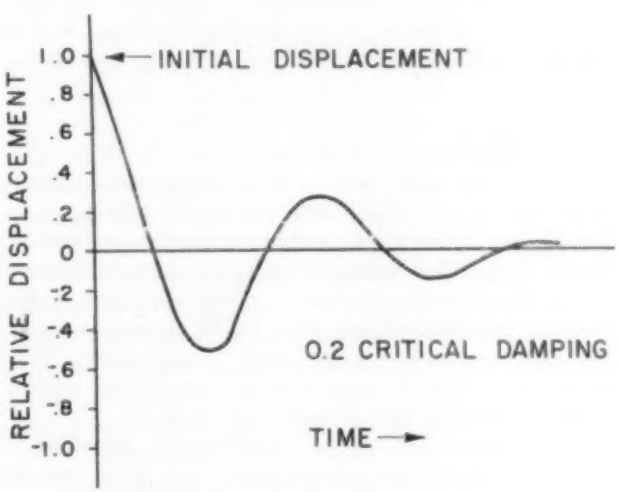

Fig. 2. Moderate damping in a seat cushion following a single disturbance, such as an air gust.

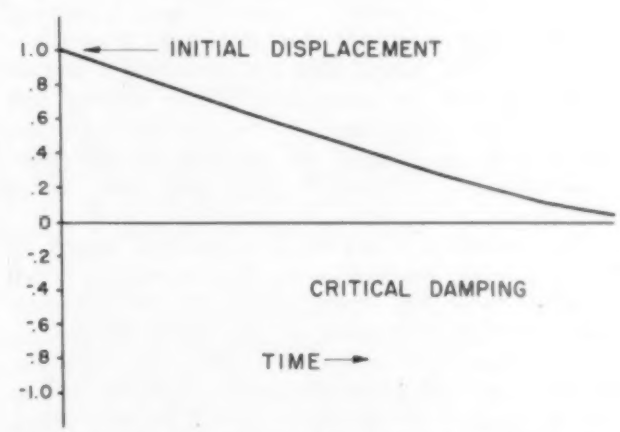

Fig. 3. Critical damping in a seat cushion following a single disturbance, such as an air gust.

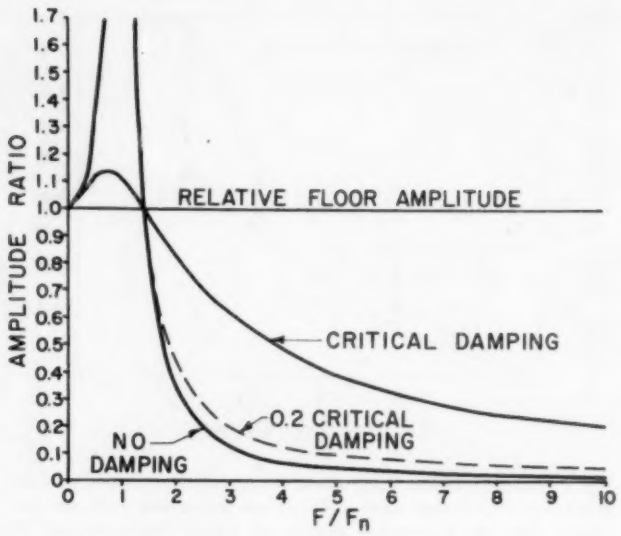

Fig. 4. Effect of damping on attenuation of a steady-state sinusoidal disturbance.

that have proved successful, it is felt that the optimum thickness range for an airplane seat cushion is 3-5 inches. It is of course possible to design a seat with no cushion materials at all, but the cushioned seat is necessary for vibration, gust, psychological, and styling requirements.

Load Deflection

An attempt has been made to define the load vs. deflection curves which will give good passenger response, yet provide the cushion manufacturer with a maximum possible tolerance. Figure 1 shows this curve for a 4½-inch thick cushion. No single latex foam material has been found which will give these properties with any core configuration. Consequently, it is necessary to have a cushion with a soft upper portion which is molded, and a firm lower portion.

Rubber manufacturers have not found it easy to meet such load deflection requirements, yet these curves closely describe the requirements of a satisfactory product. The major difficulty occurs in controlling the compression for the first deflection point of one inch and a rejection rate of 10% on parts made by experienced manufacturers is not unusual.

For those portions of the curve defined as two and 2½-inch deflection points, a wider tolerance is assigned and the rejection rate for these deflections is considerably lower and, hence, does not constitute a serious control problem. A tremendous saving in time and money in the examination of new seat cushion materials can be made merely by checking whether their compressions lie between the upper and lower curves of Figure 1.

Two observations may be in order with respect to Figure 1. First, the load at any given deflection is not permitted to vary by as much as a factor of two. Secondly, whether on the lower or upper curve, the cushion is increasingly stiff as deflection increases. To allow the left- and right-hand cushions on a double seat to vary in compression by a factor of two or more would permit the passengers to readily detect the difference. The aim is to provide each passenger with identical accommodations, for it would not be desirable for the passenger to search for the most comfortable seat.

The RMA specification on latex foam does not assure compliance with Figure 1 because only one point of the curve is specified. Proper specification of the load deflection characteristics of a cushion material must have at least three deflection points recorded to show the shape of the curve.

Because of the large number of plastic foam materials brought to the attention of the seat designer in the past few years, it has been necessary to go beyond the simple tests of Figure 1. Our process laboratories have been requested to determine other properties of the material which are of considerable concern to the designer of aircraft seats.

Vibration Damping

Damping is valuable in a seat cushion so that a passenger displaced from his normal position due to gusty weather will not oscillate for a long period after the initial disturbance. However, a seat with too little damping would give a feeling of instability, and also would help to induce motion sickness.

An undamped time-relative displacement curve would show sinusoidal motion of oscillation. Figure 2 shows the decrease in successive oscillations when 0.2 critical damping is applied. Figure 3 shows the effect of having critical damping which means that after the body is displaced from its normal position, it will never oscillate past the normal position. While this might seem to be a desirable situation to have for the isolated gust, high damping is not desirable for repeated gusts and for higher frequency vibrations; for example, those ranging from 45-70 cps. encountered in typical DC-6 and DC-7 installations due to propeller tip passage frequency. To attenuate a steady-state vibration, the

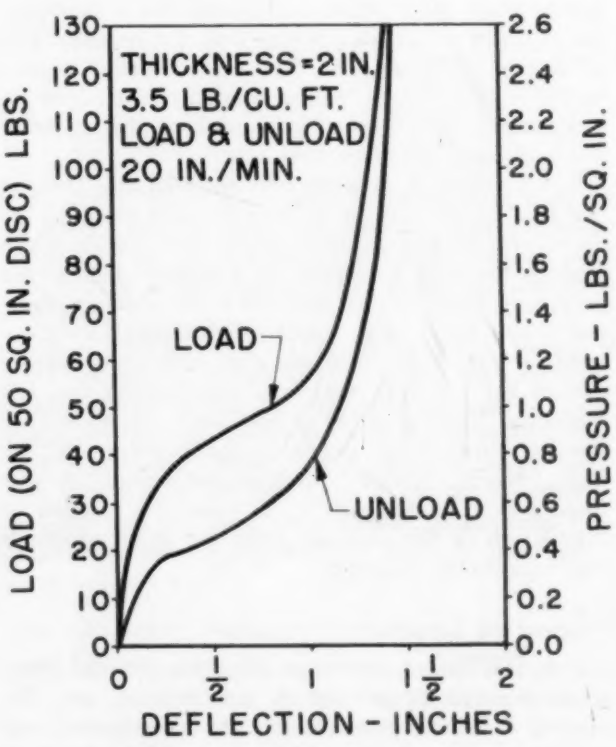

Fig. 5. Hysteresis of a polyurethane foam.

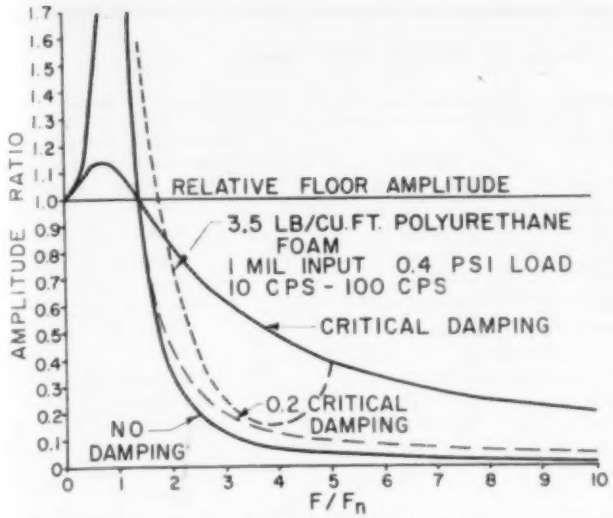

Fig. 6. Attenuation of a steady-state vibration of a mass placed on a specimen of polyurethane foam.

ideal situation would be to have a spring with no damping present.

Figure 4 shows that with a steady-state vibration, damping approximately equal to 0.2 critical damping will not seriously interfere with attenuation of the steady-state vibrations. Therefore, for design purposes, it is felt that a damping coefficient between 0.15 and 0.20 critical is a good physical statement of the requirements. The model for the above discussion is a linear spring system which is actually a simplification of the problem. It is conceivable that in another decade, it may be desirable to define cushion materials with far greater precision than seems sensible today.

Because the noted systems are not linear, it is advisable to check the vibration attenuation of the cushion materials on a vibration table. The results would not be expected to agree precisely with Figure 4.

Suitability of Plastic Foams

The question of interest at this time is "How do some of these materials qualify for usage in aircraft seats?" For several years, seat designers have been seeing an intersecting series of foamed plastics such as the polyvinyl chlorides, the polyurethanes, and, more recently, the polyethers. A series of tests is in progress at Douglas, which will help to determine if any of these materials are suitable for seating applications. A few observations on the properties of these new materials can be made at this time.

Design personnel are not so interested in the properties of a particular cushion furnished by a specific manufacturer as much as they are in determining if the classes of materials have properties in common despite the advertised claims of uniqueness. These fundamental properties of the material do not change with removal of material by coring or corrugating. The only thing that changes is the deflection for a given load and possibly the efficient use of weight. In this connection, the Douglas process laboratories report that the polyurethane foams furnished by different suppliers behave alike.

Figure 5 is a load-deflection curve taken on a Baldwin 5000-pound capacity tensile machine used as a compression tester. A two-inch thick slab of 3.5 pounds per cubic foot polyurethane foam was loaded at a rate of 20 inches per minute, and the load was removed at the same rate. Considerable hysteresis may be noted in this curve. The shape of the curve with its typical three-step spring characteristics does not fit the requirements of Figure 1. It is apparent, therefore, that some combination of different compressions or possibly different materials would be necessary to achieve the appropriate deflection characteristics.

Attempts were made to measure damping coefficients for polyurethane foam samples by displacing a load on the test specimen and then releasing the sample to oscillate freely. The intent was to measure the heights of successive peaks of a recorded curve, similar to Figure 2. However, the load did not return to the neutral position, so that damping in excess of critical damping was indicated.

The result of a vibration table test on a typical sample of polyurethane foam is shown in Figure 6. A load of 20 pounds was placed on an eight-inch diameter disc which rested on the foam sample. The supporting platform was vibrated at a peak-to-peak amplitude of one mil (0.001 inch). An accelerometer placed upon the load measured the output amplitude. Resonant frequency was 20 cycles per second.

A high variability is shown in the attenuation curve of the sample. The lessened attenuation at five times natural frequency constitutes a serious deficiency in the material. Earlier tests on latex foam revealed superior attenuation characteristics. Similar tests will be conducted on polyether foams.

Briefly, then, the information presently available on the polyurethane foams indicates that they do not appear promising when used alone.

Preliminary tests have begun on polyether foam materials, and our process laboratories feel that they show more promising properties than do the polyurethanes. These tests, however, have not progressed far enough for conclusions to be drawn.

Douglas has been using polyvinyl chloride foam as an insulation in the form of a special 4.5-5.0 pounds per cubic foot, semi-flexible material. The application has been for thermal insulation purposes in the lower cargo compartments of DC-6 and DC-7 airplanes, and the foam is used in quarter-inch thick sheets. On the whole, the response to this material has been very satisfactory.

The aircraft seat designer does not desire to get into the details of manufacture of the products he uses any more than is necessary to turn out quality products. Neither the designer nor the process laboratory personnel are interested in knowing the particular formulation of a supplier. The major concern is to be able to buy a product that has appropriate properties for the design.

Most of the material characteristics discussed have been those which insure a proper response on the part of the passengers during various flight conditions, and are considered to be primary requirements. In addition, there are other, secondary properties of the materials which cannot be neglected. Consistent and close control of foam density is a necessity. It is also mandatory that

Table 1. General Comparison of Flexible Foams for Aircraft Seat Usage.*

	Latex Foam	Polyurethane Foam	Polyether Foam**	PVC Closed-Cell Foam
Flame resistance	Poor	Self-extinguishing	?	Self-extinguishing
Aging: Dry heat	Satisfactory	Good	Good	Varies with composition and color
Humid	Satisfactory	Poor for high density; good for low density	Good to fair	Fair to poor
Compression set	Good	Variable	Good	Poor
Abrasion resistance	Poor	Good	Good	Fair
Density #	Poor	Good	Good	Poor
Commercial quality control	Fair to poor	Non-existent	Non-existent	Good
Availability	Good	Good	Experimental	Good
Ease of fabrication in aircraft quantities	Fair	Good	Good	Good (flat stock only)
Cost	Moderate	Moderate	High	Moderate
Thermal conductivity	Not critical	Not critical	Not critical	Not critical
Porosity (for cushion ventilation)	Good	Good to fair	?	Poor
Flex life	Fair	Good	Good	Varies with plasticizer
Chemical resistance	Fair to poor	Good	?	Good
Effect of low temperature (to −60° F.) on compression	Slight	Stiffens	?	Stiffens (varies with plasticizer)
Effect of high temperatures (to +160° F.) on compression	Slight softening	Slight softening	?	Slight softening

*Properties noted are based, for the most part, on work performed to date by the Douglas process laboratories, with judgements made with respect to seating applications. All materials were those furnished to Douglas.
**Some properties are those stated by the supplier. Douglas' tests are not completed.
#Low density is "good"; high density is "poor."

a cushion have reasonable service life without a permanent set or change in properties. This means good life even in case of spillage of liquids and frequent removal of covers for cleaning.

Whereas the polyurethane foams are superior to latex foam in tear resistance, our process laboratories have found the denser polyurethane foams to have a tendency to hydrolize and become soggy. These properties and others which relate to service life and safety, but not to passenger response, are shown in Table 1. This table is designed to indicate that after primary properties affecting comfort and safety are satisfied, a number of secondary attributes of a new foam should be investigated.

Conclusions

It is not desirable for a company to tailor its requirements to a particular product of a single manufacturer. Yet if a particular material is to be described, much paper work is involved and quality control is difficult. The errors in defining latex foam in a manner suitable to the aircraft industry should not be repeated with the new foam materials coming into the market.

Interest shown in developing proper specifications is commendable. The early introduction of standard methods of testing and description of the new foam materials will save innumerable rejections, letters of inquiry, conferences, and other wasteful efforts.

Acknowledgements

The author wishes to express his appreciation for the assistance of Mrs. Carol Baxter and Mr. Rudy Gonzalez in the preparation of this paper.

—The End

Marlex 50 Polyethylene—
A New Material of Construction

(*Continued from page 24*)

time and the ingenuity of the plastics industry will bring forth countless applications for this polyethylene that are not even envisioned at present.

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—The End

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Polyester Resin Evaluation with Short-Time Flexural Creep Tests

Details of a rapid, simple test which measures plasticity of a reinforced plastics laminate as a function of temperature and stress.

ALMOST all end-uses of reinforced plastics in the electrical industry will involve the combination of appreciable stress and elevated temperature. In general, our experience has shown that tests which involve sustained loads at service temperatures are far more revealing than short-time tests to failure, even when made at high temperatures. True creep tests, however, run for such a long time as to prohibit their use for preliminary screening and evaluation. What is sought is a procedure which has the validity of the long-time creep test and the convenience of short-time load to failure procedures.

When strength tests are used to evaluate resins in reinforced plastics, the results are dominated by the reinforcement. When variations are encountered in test results, it is often difficult to know whether to ascribe them to variations in resins or reinforcement.

This difficulty may be overcome by the use of a test procedure which, in any given sample, neutralizes the effect of this reinforcement and indicates directly the degree to which a given resin has been cured to optimum properties. Such a procedure is the subject of this paper and has been found to be reproducible and very sensitive to cure cycle variations. The same procedure may be used to compare different resins and determine the optimum cure cycle for each.

The method was originally developed in response to a need for a fast and simple production control test as a watchdog on resin mixing and cure cycle variations. During the process of working out the variables in the method, unusual effects were encountered which were later recognized as permanent undercuring. The existence of this kind of phenomenon has long been suspected, but this was the first time a convenient tech-

nique was at hand to study it and related effects. What began as a greatly simplified quality control test revealed itself as a research tool of considerable potency.

The presentation to be given follows the historical evolution of the method. Data will be presented to show how the method may be used to follow the cure of a resin in a laminate, and the improvement achieved by after-bakes. "Permanent undercure" will be discussed, wherein curing reactions are arrested prematurely, so that they cannot be brought to completion by additional heating. These are demonstrated by a detailed comparison of three typical polyester resins, which may be ranked by this test procedure.

In this phase of the project, the test was made under specified fixed conditions, and the results were expressed in terms of an arbitrary factor of merit designated as the "creep factor." By comparing "creep factors," it becomes possible to demonstrate differences in materials and to rank them on the assumption that the lower the creep factor, the more suitable the material for load bearing duty when hot. At this stage of development, however, it is recognized that this procedure shares the limitations of similar arbitrary tests in that they all measure something, but no one is sure of quite what that something means.

The last part of the paper attempts to relate creep factor to the fundamentals of stress and temperature. Correlation between long-time creep tests and other methods of evaluation are attempted. The intent is to develop a system of evaluation in which a large number of short, simple experiments delineate the safe operating ranges of temperature and stress for a specific material. Long-time confirming tests are thus reduced to a minimum, and may be run in the most significant region.

Test Procedure

The fundamental assumption is made that the more desirable reinforced plastic systems are those whose characteristics at service temperature show the least deviation from those at room temperature. Conversely, those materials which suffer a gross loss of load-bearing capacity as the temperature is raised are considered unsuitable. The experimental procedure proposed attempts to make this comparison in the most direct manner possible, so that the difference in behavior of the same sample at two temperatures is made the criterion of merit.

The use of the same sample at two temperatures eliminates the problem of molding two specimens with an identical placement of reinforcement, and adopting a dead-weight loading system insures that identical stress acts in both cases. Under these conditions, any change in behavior must result from the effect of temperature on the load-bearing properties of the resin.

As now developed, a flat flexural specimen is loaded with a dead weight, and the deflection noted as soon as the weight is well seated. The sample is then unloaded and heated to test temperature, usually 125° C. or higher. When the sample has attained test temperature, the dead weight is replaced, the initial deflection recorded, and deflection with time is noted.

Typically, the sample creeps rapidly immediately after application of the load, and during the first 30 seconds of test. The rate of creep gradually diminishes with time; after the first two minutes have elapsed, little additional information of significance is obtained, unless the test runs for a very long time. A slight amount of permanent set often is noted after unloading at room temperature. This is ascribed to seating the sample. The apparatus is rezeroed just before the application of load for the hot test.

This technique is very sensitive to change in cure of the laminate. Materials which are poorly cured, even though strong and hard to all appearances, will fail on loading or run off the travel of the dial indicator in about a minute. Conversely, laminates of high quality will creep only two or three mils during the first 30 seconds and almost nothing thereafter, when tested hot.

A standard sample for these tests is cut ½ inch wide from a panel 3/16 inch thick molded from 15 plies of 16x14 construction cloth.* Tolerances of ±10 mils are maintained on the samples. The strips of laminate are placed in the specimen holder of an ASTM heat distortion tester, and the dial indicator zeroed with the weight of the loading rod. A weight of 15.9 pounds is placed on the loading rod and the deflection of the specimen noted, and then the load removed.

The sample is then heated in an oil bath to test temperature, usually 125° C., for four minutes; this time having been verified by thermocouples molded in the sample. When the specimen is hot, the 15.8-pound test weight is replaced and as the load goes on, a stop watch is started and the deflection with time followed for two minutes. The test set-up is shown in Figure 1.

The loading rod weighs 1.1 pounds and places a prestress of approximately 300-400 psi. on the sample, depending on variations in dimension. The test load has been arbitrarily fixed at 15.9 pounds which, in combination with the loading rod, gives a total load of 16.9 pounds or nominally 5,800 psi.

Typical data from this kind of experiment are shown in Figure 2. The lower curve is deflection at room temperature plotted against time, and the upper curve is for the same sample reloaded at 125° C. The item of interest is the difference in behavior of the same sample at the two temperatures.

In order to simplify the presentation of data when a large number of samples are to be compared, recourse is had to an arbitrary criterion of merit, derived as follows: If D_1 is the initial value of the deflection at room temperature, and D_2 the value of deflection after two minutes at the test temperature, then the "creep factor," ϕ, is given by:

$$\phi = D_2 - D_1$$

Both deflections are expressed in mils. The derivation of ϕ is shown graphically in Figure 2.

A low value of ϕ indicates the behavior of the sample at two temperatures to be essentially the same; that is, the resin is comparatively unaffected by temperature. Conversely, a high value of ϕ indicates a high creep rate, and augers for early failure if the conditions of service approximate those of the test.

The procedure of subtracting the cold deflection from the hot deflection produces a large numerical change in ϕ for small changes in creep when the creep factor

*Such as United Merchants Style 1000, Soule Mills MS 500, or Hess Goldsmith HG 63.

is small. It also has the effect of approximately neutralizing small changes in flexural modulus brought about by variations in glass disposition. Lower flexural modulus has the effect of producing a higher room-temperature deflection, but as the hot deflection is similarly increased, the difference is practically constant. If low flexural modulus is produced by uncured resin, the hot deflection shows a very pronounced increase.

With a fixed dead weight load, changes in sample dimension have the effect of changing the outer fiber stress in the sample. The effect of stress level on these experiments are discussed later in detail; however, stress changes from 5,500 to 6,500 psi. do not significantly alter the results.

Most of the work reported compares behavior at 25° C. with that at 125° C. (250° F.). The test is not restricted as to temperature, and very interesting results may be obtained by testing at several temperatures. The effect of temperature is discussed more fully elsewhere.

This test was originally built around 15 layers of the comparatively thick open-weave cloth previously designated. This test is useful with other reinforcements. In these cases, however, the load specified may be either too light or too heavy for good comparisons.

Usefulness of the Test

The scope and usefulness of this type of test method may be illustrated by data taken from a series of experiments designed to screen and give a preliminary evaluation of three polyester resins designated as resins "A," "B," and "C." The type of resins worked with may be best understood from Table 1, which reports the conventional data available on these products.

The composition of resins "A" and "C" are not disclosed, except that they are styrene-bearing polyesters of high reactivity and peak exotherms up to 200° C. It is known that resin "B" has a propylene glycol maleate-phthalate alkyd combined in a ratio of 1.0 mol maleic anhydride to 0.66 mol phthalic anhydride.

Figure 3 depicts a typical experiment to investigate cure on resin "C". A standard panel was molded in a press and cut into uniform 0.500 x 0.187-inch strips. These strips were tested as molded and after oven bakes at 150° C. for 1½, 4, and 24 hours. Each strip was loaded at room temperature for two minutes at 125° C. for the same length of time. The room temperature deflection of all samples tested was the same ±1 mil, indicating the glass reinforcement in each to be comparable.

When the samples were loaded hot with only short press cure, excessive creep was observed. The creep gradually improved with increasing hours of post-bake. In this system, cure was substantially complete after four hours bake following the molding cycle, and the creep at 125° C. was only slightly greater than that at room temperature. These data are typical of the types of results obtained throughout the entire program.

Effect of Catalyst Concentration

Rate of cure of resin "C" as a function of catalyst concentration is shown in Figure 4. In this experiment, three panels were molded using resin containing 0.2, 0.4, and 1.5% benzoyl peroxide catalyst. The time and temperature of the panel during molding was followed by thermocouple and reproduced in the inset on the figure. It is clearly seen that low amounts of catalyst concentration yield parts which show a very high value of ϕ, indicating poor load-sustaining properties at the temperature of test. When 1½% benzoyl peroxide is used, the part is substantially cured on removal from the press,

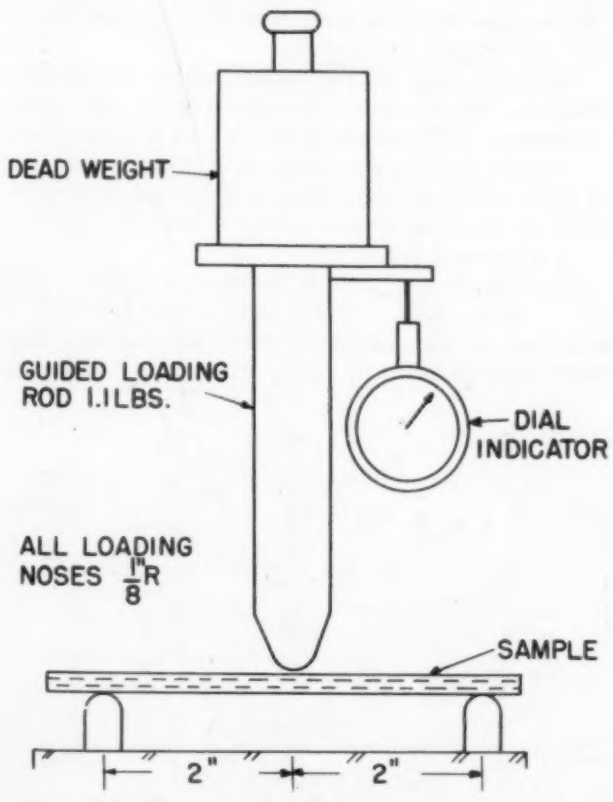


Fig. 1. Schematic representation of test apparatus.

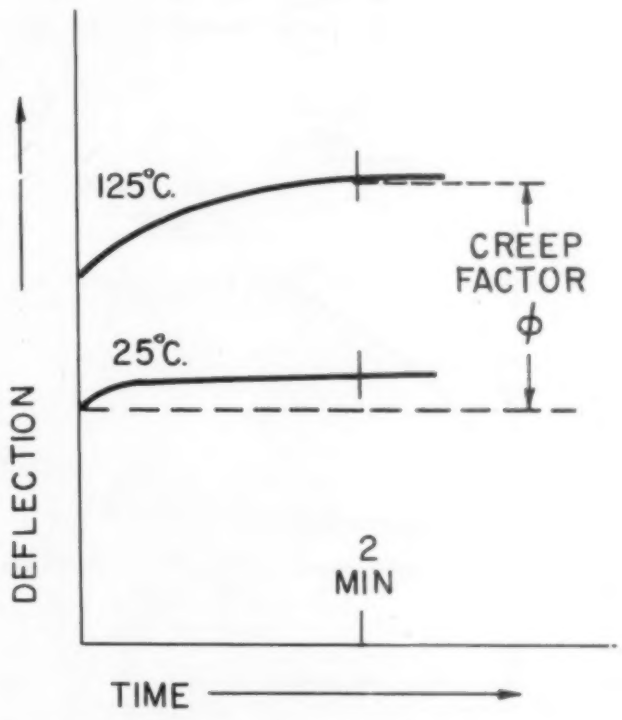


Fig. 2. Data obtained by loading the same specimen at two temperatures, showing the derivation of "creep factor."

and comparatively minor improvement is obtained by post-curing.

It should not be taken for granted that large catalyst concentrations are always beneficial. Figure 5 shows creep factor (ϕ) ploted against catalyst concentration for "A", "B", and "C" polyester resins when t-butyl perbenzoate is used as the catalyst. Resin "C" shows improvement with increased catalyst up to 2%, but contrasts with resin "A" where the optimum concentration is in the order of 1% and greater or smaller amounts give inferior properties.

Tert-butyl perbenzoate was found to give somewhat lower creep factor values than did benzoyl peroxide. Unfortunately, however, it gelled resins "B" and "C" at room temperature in about four hours.

Permanent Undercure

The typical pattern thus far is for the creep factor "as molded" to be fairly high, dropping with increasing time of post-baking to a steady state. In the case of resin "C", values of creep factor level off to the range ϕ=6-12. Resin "B" likewise is considered optimum at ϕ=15-20.

Phenomena will now be discussed where the value of ϕ remains high, and cannot be brought down by extensive post-baking. This condition is designated as "permanent undercure".

In our experience, permanent undercure is associated with (1) low catalyst concentrations, and (2) high exotherms in the mold. Referring back to Figure 4, it is seen that with 1½% benzoyl peroxide, good parts emerge directly from the mold, although the exotherm during molding shot up to 160° C. When ½% benzoyl peroxide is used (See Figure 6), the material becomes exotherm sensitive, and the final properties after a four-hour post-bake clearly show the adverse effect of exotherms during molding.

Similar results are obtained with resin "B", and the data may be of some interest because they are taken from production molds. The process was originally set up so that a piece of trim served as a sample for a creep factor test for quality control purposes. A situation developed where samples "as molded" failed on loading. After baking for 24 hours at 125° C., the creep factor value could not be brought below ϕ=70, which was considered excessive.

Table 1. Properties of Three Polyester Resins (Clear, Unfilled Castings).

	Resin "A"	Resin "B"	Resin "C"
Tensile strength, psi.	—	6,800	2,500-3,500
Compressive strength, psi.	23,000	—	34,000-36,000
Flexural strength, psi.	15,700	13,700	13,000-15,000
Modulus, psi. x 10^5	4.9	6.5	6.0
Heat distortion temperature, °C.	117	120	165-170
Flexural strength, psi., of 15 plies 16x14 cloth (as used in creep evaluation program)	38,000	31,000	22,500
Modulus, psi. x 10^6	2.3	2.2	1.9

Thermocouples embedded in the lay-up gave the complete time-temperature heating cycle of the molding (see Figure 7), showing exotherms up to 190° C. Investigation showed a failure of the temperature control, so that the mold was running 20° C. too hot. When curing cycles were restored to normal, the creep factor dropped to ϕ=20-35 right out of the press, and only a few hours post bake had the usual effect of giving a final value of ϕ=15-20. Dropping mold temperatures still further yielded parts showing the softness and deep green color associated with conventional undercure. A very short additional heat treatment was all that was needed to bring these parts into the acceptable creep factor range.

Optimum cure usually results when (1) adequate catalyst concentrations are used; (2) the mold temperature is just sufficient to initiate an exotherm; and (3) the exotherm is not sustained. If attempts are made to have no exotherm, difficulty is likely with soft undercured parts subject to damage due to handling when the mold is stripped hot.

Good economics require the shortest possible cure cycle. These data indicated that when load-bearing properties at elevated temperatures are required, high speed high-temperature mold cycles may deteriorate

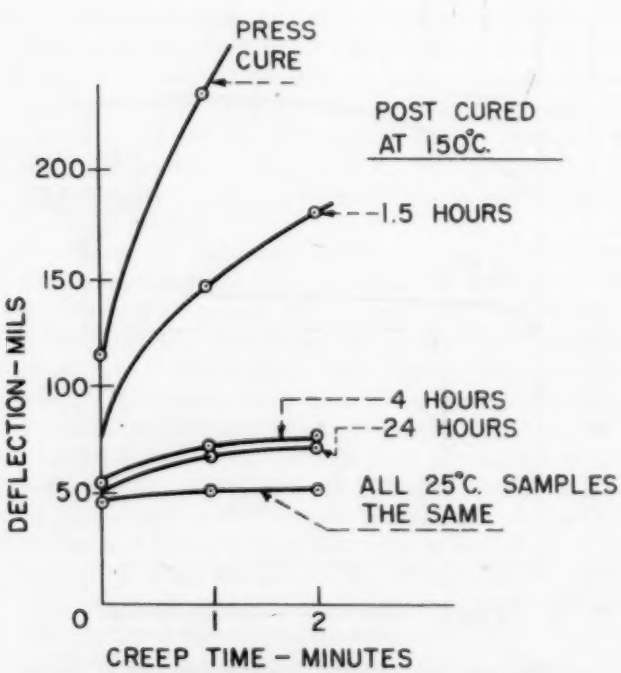


Fig. 3. Results of tests on cure of Resin "C."

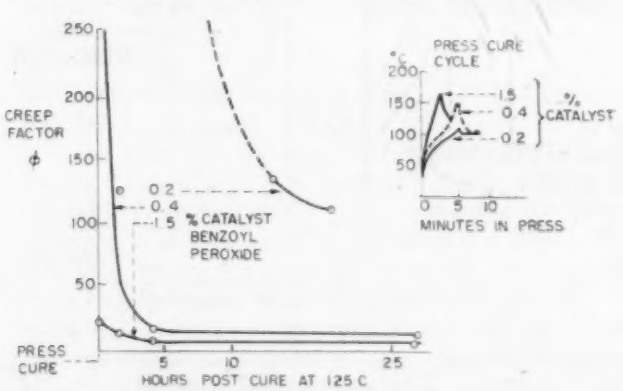


Fig. 4. Creep factor as a function of catalyst concentration and time of after-bake of Resin "C."

part quality more than has been appreciated.

The subject of permanent undercure has been investigated by Parkyn (1)** who was primarily concerned with room-temperature curing systems. Evidence is shown in his paper that reinforced-plastic works may apparently be strong and hard, but deficient in water and chemical resistance, and that this cannot be corrected by subsequent heat treatment. Cold work rooms for room-temperature lay-ups, as well as fillers and reinforcements that are not completely dry, are cited as tending to produce this condition. It is believed that these observations are manifestations of the same kind of phenomena discussed in this paper.

The above discussion illustrates how an optimum curing cycle may be worked out for a given resin and catalyst system. For superior hot strength, it is apparently necessary to provide adequate catalyst concentration, and to cure the part under conditions which produce only a moderate exotherm which is not sustained. Extended post-baking is almost always beneficial.

When the foregoing approach is used to compare resins "A", "B", and "C", the results obtained are shown in Figure 8. This bar graph shows the maximum and minimum value of the creep factor obtained in 27 comparative experiments. The data are organized to show the range for a press cure only; a press cure followed by four hours bake; and a press cure followed by 24 hours bake at 125° C. The somewhat wider range between maximum and minimum shown for resin "A" is ascribed to the belief that this material is a little more erratic in its curing characteristics than are the other two resins.

The implications of these data are that resin "C" is the most suitable of the three resins for load-bearing duty when hot, while the somewhat erratic characteristics and higher creep factor of resin "A" make its selection unattractive.

This ranking is confirmed by a 700-hour creep test run at 5,800-psi. on these same materials in a circulating air oven at 125° C. The results of this creep test are shown in Figure 9, which plots deflection in mils vs. log time in hours. The value of ϕ shown on each curve was obtained by loading the sample at room temperature and comparing that to the value of deflection taken after two minutes of loading in the creep test.

The data cited are not completely conclusive, but the preliminary evidence indicates that a low value of creep factor correlates with good performance in long-time creep tests.

Reproducibility of Cure

One important, desirable feature of a resin system is its reproducibility and freedom from capricious effects which are hard to control.

Figure 10 shows the reproducibility of cure for the three test materials, in which three separate panels of each resin were molded. The resin in each case came from the same factory batch, but it was individually

**Numbers in parentheses refer to bibliography at end of article.

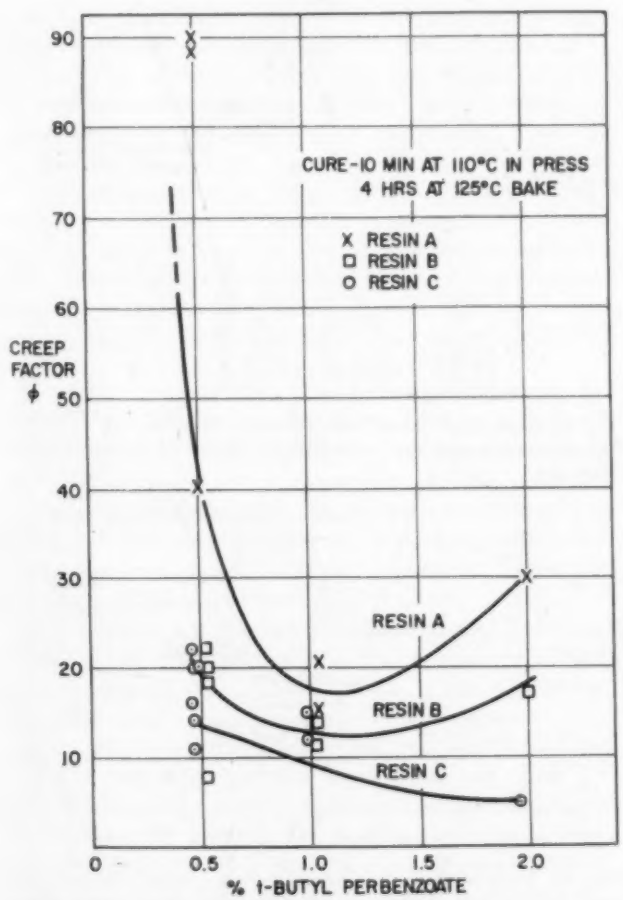


Fig. 5. Effect of catalyst concentration on creep factor.

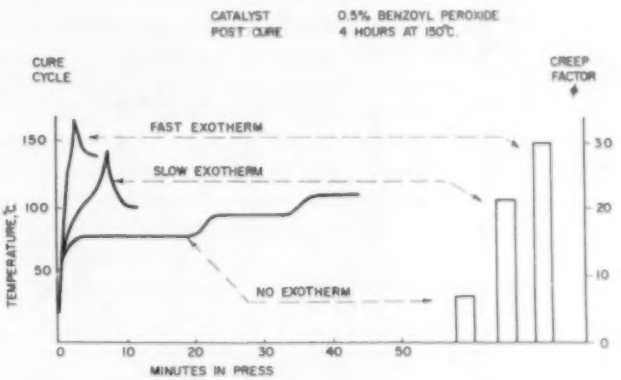


Fig. 6. Effect of exotherm during cure on creep factor of Resin "C" with low catalyst concentration.

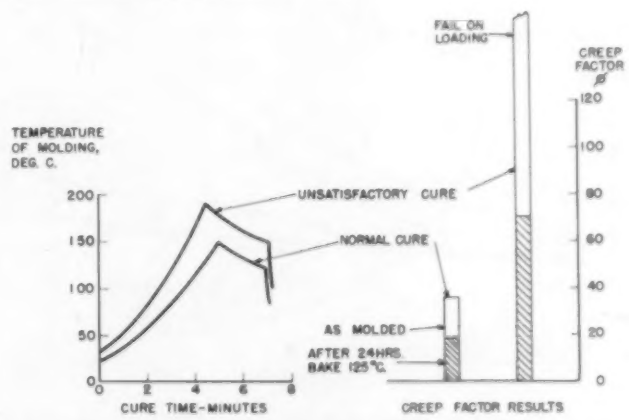


Fig. 7. Permanent undercure of Resin "B" in production molds.

catalyzed for each panel. Both resins "C" and "B" give results which are closely grouped. Resin "A", however, is somewhat erratic in its response.

These data are typical of the results of the over-all investigation involving approximately 160 determinations in which the same pattern was shown. Apparently, resin "A" is roughly equivalent to resin "B" when cured to its optimum properties, but it is difficult to do this every time.

Room-Temperature Curing Systems

One of the most attractive features of polyester resins is the ease with which they may be set at room temperature. This makes possible the production of large and complicated shapes in unheated molds. With complicated lay-ups, material of long pot life is desired, which implies small additions of room-temperature setting catalyst. Concern has been expressed lest these minute peroxide concentrations be insufficient to induce complete cure.

The left hand portion of Figure 11 shows the results of such a curing system which used the least practical amount of methyl ethyl ketone peroxide with cobalt napthenate. Benzoyl peroxide also was present to aid cure in subsequent oven bakes. This panel was molded and cured for 24 hours at room temperature, then tested by the procedures outlined previously. The comparatively high creep at 25° C. shows this sample to be far from completely cured.

This experiment, which revealed higher creep at room temperature than at elevated temperature, is of considerable practical importance. Care must be taken that parts cured with a similar room-temperature curing system are protected against stress when first exposed to heat. The application of heat will induce a preliminary weakening of the part before the additional heat-induced cure brings the part to full strength. In very large parts, the weight of the piece may be enough to deform it during bake. The author has had experience with two jobs that got into serious difficulty before this effect was understood.

Slow room-temperature cure followed by a bake at no stress is illustrated in the right hand side of Figure 11. Samples were cut from the same panel after six hours cure at room temperature, and given a 16-hour bake at 125° C. prior to testing. The results on this material were equal to the best heat-cured samples made in this investigation.

In an attempt to see if room-temperature cure would go to completion if left long enough, samples were tested at periods up to six weeks exposure at room temperature. The properties measured at room temperature fell into the normal range; when tested at 125° C., however, the sample showed a creep factor of 40, which indicates an incomplete cure. These experiments were performed only with resin "B".

Perhaps with some resins, complete cure can be obtained at room temperature. At this writing, however, it seems mandatory to bake parts cured at room temperature, and heat-setting catalyst should be added to the curing ssytem in order to be available during the bake.

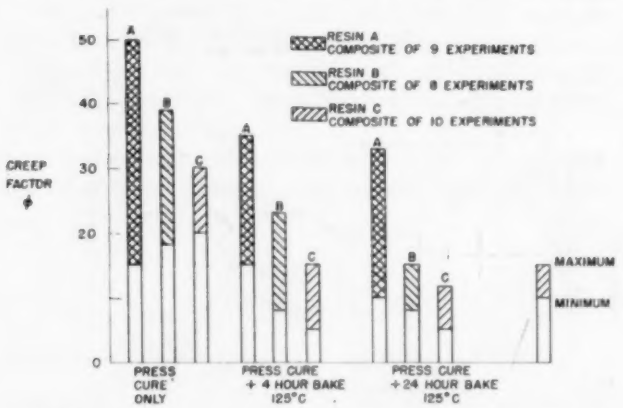

CREEP FACTOR ϕ
RESIN A COMPOSITE OF 9 EXPERIMENTS
RESIN B COMPOSITE OF 8 EXPERIMENTS
RESIN C COMPOSITE OF 10 EXPERIMENTS
MAXIMUM
MINIMUM
PRESS CURE ONLY
PRESS CURE + 4 HOUR BAKE 125°C
PRESS CURE + 24 HOUR BAKE 125°C

Fig. 8. Ranges of creep factor values for Resins "A," "B," and "C" after three types of cures.

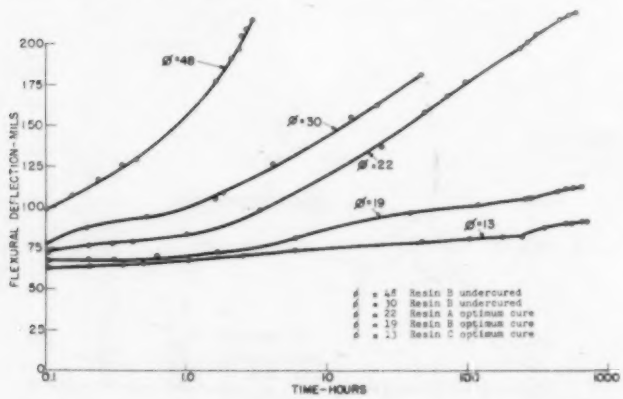

FLEXURAL DEFLECTION - MILS
TIME - HOURS
ϕ = 48 Resin B undercured
ϕ = 30 Resin B undercured
ϕ = 22 Resin A optimum cure
ϕ = 19 Resin B optimum cure
ϕ = 13 Resin C optimum cure

Fig. 9. Correlation of long-time creep properties with creep factor. Creep data shown from six minutes to 700 hours.

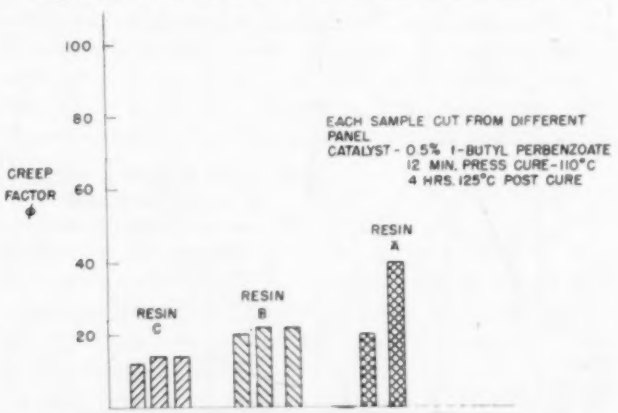


Fig. 10. Reproducibility of cure of Resins "A," "B," and "C" when two separate panels are molded under conditions designed to be identical.

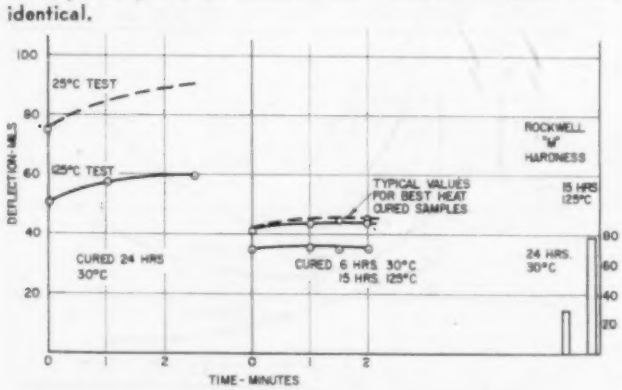


Fig. 11. Study of room-temperature curing systems. Catalyst system: 0.5% cobalt naphthenate; 0.1% methyl ethyl ketone peroxide; 0.5% benzoyl peroxide.

Table 2. Phthalate-Maleate Ratios in Test Resins.

	ASTM Heat Distortion Temp., ° C.	Moles Phthalic Anhydride	Moles Maleic Anhydride
Resin I	70	1.62	1.0
Resin II	100	1.0	1.0
Resin "B"	117	0.66	1.0

Hardness Determination

Because a hardness test may be made easily on a sample of almost any size and shape, a great deal of work was done to see if a hardness determination could be used to determine optimum cure. The use of hand-hold Barcol hardness testers is a well accepted method in the industry for determining cure.

Both Barcol and Rockwell hardness measurements were made at room temperature and at 125° C. The most significant results are shown in Figure 12, and show Rockwell "M" hardness measured at 125° C. vs. creep factor. The data show a trend for increasing hardness with decreasing creep factor, but the results show very high scatter. It is believed that this scatter may be partially ascribed to the open weave of cloth used.

Examination of the data shows that hardness measurements are not very reliable. Hardness measurements appear to be useful only in detecting grossly undercurred resins.

Effect of Temperature

All the experiments cited thus far have compared behavior at only two fixed temperatures, 25 and 125° C. The scope of the method may be greatly increased if creep factor determinations are made as a function of temperature. In general, reinforced plastics show a slowly increasing creep factor as the temperature of test is increased until a critical zone is reached. Then, further increase in temperature produces a rapid increase in creep factor until the samples fail on loading. The region of temperature at which this transition takes place is characteristic of the resin, and may be shown to be a measure of the degree of internal cross-linking in effect at the time the determination is made.

In order to show how this procedure responds to cross-linking in polyester resins, Table 2 gives a comparison of three resins having increasing amounts of unsaturation in the alkyd component. In this case, the degree of potential cross-linking was governed by varying the ratio between phthalic and maleic anhydride, the higher concentration of maleic anhydride producing greater cross-linking potential.

These resins are designated I and II, and are compared to resin "B" in Table 2, which also shows the phthalate-maleic ratios. Resin I is a "general-purpose" polyester resin.

The standard creep factor test was performed on laminates molded from the three resins (of Table 2) at optimum cure, and the results are shown in Figure 13. In this case, creep factor, ϕ, is plotted against temperature in degrees C., showing a sharp rise in creep factor at 75, 100, and 160° C. for resins I, II, and "B," respectively. Resin I failed on loading at 100° C, resin

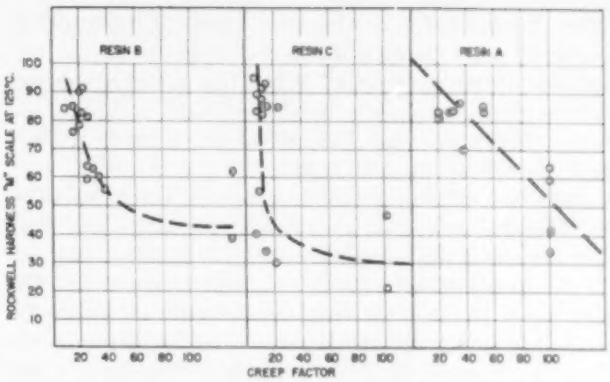


Fig. 12. Correlation of Rockwell hardness and creep factor.

II failed at 125° C., while resin "B" held load at 160° C. The improvement in properties with increased cross-linking is obvious from these data.

The shapes of these curves closely resemble those obtained by an ASTM heat distortion temperature test when the complete deflection vs. temperature cure is given. Other workers (2) (3) have shown that heat distortion temperatures of thermoplastics and clear, unfilled, cast polyester resin may be used to follow cross-linking. The "temperature" of an ASTM heat distortion test is, of course, a function of time, so that both the ASTM test (complete curve) and the creep factor test probably measure the same property in slightly different ways.

The ASTM heat distortion test and the creep factor test may be compared in detail as follows: A description of the mechanical properties of a reinforced plastic requires analysis of the time, temperature, loading, and deflection variables. The creep factor test as now developed fixes time at two minutes, temperature at 125° C., loading at 5,800 psi. in simple bending, and measures deflection. An important feature of the test is the zero reference which is taken as the zero-time deflection of the same specimen at room temperature. The value reported is the plastic deflection occuring at 125° C. in two mintes of time.

The data obtained in a creep factor experiment may

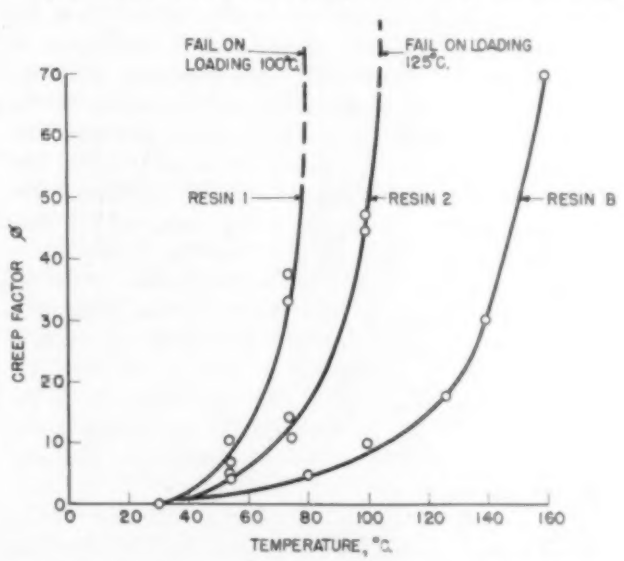


Fig. 13. Effect of temperature on creep factors of three polyester resins of increasing cross-linking.

be directly related to similar information taken at other times, temperatures, and loadings, so that it is possible to construct plots showing the overall response of the material to all these variables. When this is done, valuable information concerning maximum safe loadings and temperatures may be obtained which is more realistic than short-time tests to failure.

The heat distortion test involves the same variables, but heats the sample at a predetermined rate under load. The deflection observed, therefore, is the integrated sum of the contributions of both time and temperature. The end point is taken as that temperature at which the beam has deflected 10 mils. However, the sample has been undergoing creep as a result of the time it has been under load. Since creep is a complicated function of both time and temperature, it is difficult to make an analysis that will relate the variables of time, temperature, loading, and deflection to one another.

Consequently, it is believed that the kind of procedure represented by the creep factor test offers important advantages in interpretation over the heat distortion test. From a purely practical standpoint, the creep factor test is much more rapid, and the samples used may be cured so as to duplicate molding practice. It is difficult to cast heat distortion bars of polyester resins and obtain strain-free and crack-free specimens.

The heat distortion test was developed originally for evaluation of thermoplastics. When it is used on laminates bonded with thermosetting resins, the temperatures reported are so high as to not be significant, and the thermal expansion of the sample may interfere with the results. The creep factor test, on the other hand, was developed primarily for use with laminates.

The heat distortion test does not always correlate with creep factor determinations. Figure 14 plots creep factor vs. temperature for a number of resins used in reinforced plastics. Where available, heat distortion temperatures also are cited. In addition to resins "B" and "C," this plot includes a straight epoxy, an epoxy-modified polyester designed for wet-strength retention, a high-temperature phenolic, and a highly cross-linked polybutadiene polymer. The tests were made on laminates of the same construction as the other experiments.

It should be noted that the epoxy, resin B, and the epoxy-modified polyester show a wide divergence in creep factor vs. temperature characteristics, although the heat distortion temperatures are essentially in the same order. It should be borne in mind, however, that the creep factor test is run on laminates, whereas the ASTM test is made on clear resin. It is speculated that the epoxy-modified polyester, being designed for wet-strength retention, has superior bonding properties to the glass and, thus, makes more efficient use of the reinforcement. Despite a heat distortion temperature of 111° C., this assumed superior wetting of the glass is responsible for its outranking at 125° C. of resin "C" (heat distortion temperature, 170° C.). However, as the temperature is raised to 160° C., this advantage is lost and resin "C" with the higher heat distortion temperature becomes superior.

The unmodified epoxy resin has an excellent reputation as a high temperature adhesive, and this example is included in the Figure to show that a reasonable heat distortion temperature and successful application in one

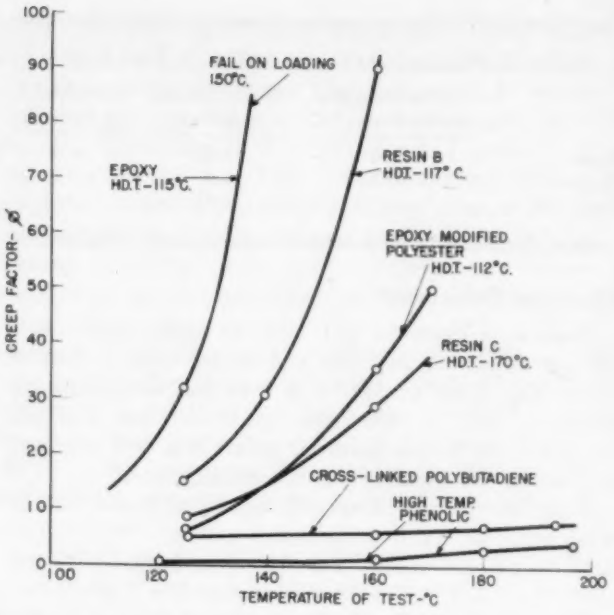


Fig. 14. Creep factor vs. temperature for various laminates. HDT is ASTM heat distortion temperature, as furnished in data from the resin supplier.

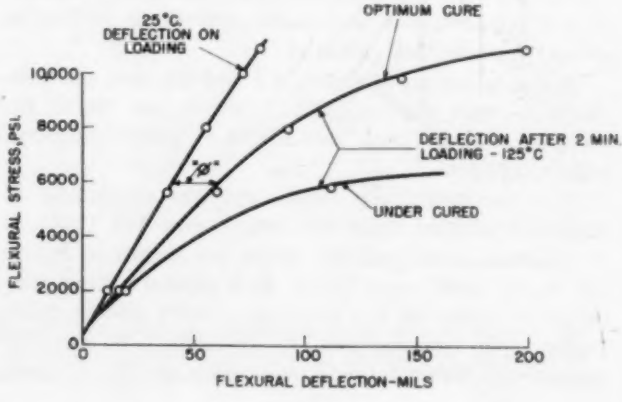
field do not necessarily forecast correspondingly good performance in another field.

Attention is drawn to the almost negligible creep factor of the high-temperature phenolic and the polybutadiene polymer in Figure 14. Apparently, these materials are in a different class compared to the other resins shown, and the inference is drawn that for really high temperature work, these would be the materials of choice. Of greater importance, however, is the kind of insight, and the opportunities for comparison a two-minute experiment of this type affords. In passing, it may be noted that all the information in Figure 14 represents less than one day's work for a laboratory assistant.

Effect of Stress Level

By adjusting the dead-weight load and the sample dimensions, it is possible to make creep factor determinations at a variety of stress levels. As previously described, the determination involves loading a sample with a dead-weight load at room temperature and read-

Fig. 15. Analysis of laminate made from Resin "B," in terms of stress and cure. At any stress level, the creep factor is the horizontal distance between the 25° C. deflection curve and the curve showing two-minute deflection at 125° C.



ing the deflection, thus obtaining one point on a conventional stress-strain curve. The use of a number of samples and loads permits the obtaining of additional points so that a room temperature stress-strain curve may be constructed. However, the variability of samples may give a greater scatter of points than is usually obtained when one sample is continuously loaded with a testing machine.

The creep factor test requires that the sample be reloaded at elevated temperature with the identical stress used at room temperature and the deflection be read off after two minutes of load application. Each hot determination gives a point on a second stress-strain curve which is offset from the room temperature curve by a separation equal to the combined effects of a lower flexural modulus #, and two minutes of creep. This offset has been defined previously as ϕ. At low stress levels where creep is small, the two curves lie very close together; as the stress is increased, the separation accelerates until a stress is reached where the hot sample fails on loading. The item of interest in this approach is the separation of these curves as a function of increasing stress.

Figure 15 shows an analysis of resin "B" by this method, both for optimum cure and somewhat incompletely cured. It will be observed that below 2,000 psi. stress, the room temperature stress-strain curve and the curves showing increased strain due to two minutes of creep at 125° C. lie essentially together. At 6,000 psi., increased separation is evident; the incompletely cured material showing an excessive separation. The optimum cured material shows a similar departure at 8,500 psi., and fails on loading at 1,100 psi.

These data were obtained to indicate the amount of variation in cure that could be tolerated in this system for successful operation at 2,000 psi. and 125° C. when creep factor measurements at 6,000 psi. were used to control cure. Because of the manner in which these curves converge at low stress levels, slight changes in creep factor at 6,000 psi. are not significant in terms of 2,000-psi. operation. In this case, a decision was reached, based on opinion that the degree of undercure represented in this chart was nearing the upper limit that could be tolerated.

Inspection of this curve (Figure 15) makes it obvious that if this system is to operate at stress levels higher than 2,000 psi., adequate assurance must be had that the resin is cured to optimum properties. It is also seen that under the best of conditions, this particular resin-glass system would introduce a good deal of risk if it were to be operated much above 8,000 psi. at 125° C.

The data taken on resin "B" present an interesting contrast to similar data taken on a high-temperature phenolic resin, the glass reinforcement being the same in both cases (see Figure 16). With the phenolic, stress was carried to 16,000 psi. and temperature to 200° C., and only a very slight separation between the room-temperature stress-strain curve and the two-minute creep curve at 200° C. are noted.

Discussion of Results

One general conclusion that may be reached from this work is that reinforced plastics, even though made with thermosetting resins such as polyesters and epoxies, show definite plastic properties at certain conditions of temperature and stress. Plasticity is evidenced by a high creep rate; a tendency to take permanent set when unloaded; and sensitivity to small changes in cure. Plastic behavior may be induced by high temperature and low stress, high stress and low temperature, or by intermediate conditions. The type of behavior is very similar to that obtained with thermoplastics when stressed at low levels at temperatures well below their softening points.

It is believed unwise to operate reinforced plastics at temperatures and stresses at which plastic behavior may be encountered, not only because of possible high creep rates, but because material in this condition is so sensitive to changes in cure that the risk of unknowingly getting poor parts is high. Knowledge of the range of temperature and stress likely to produce plasticity in any resin-glass system is, therefore, of importance to the designer of reinforced plastics parts. It is believed that the experimental procedures presented in this paper are particularly suitable for defining and exploring plasticity characteristics.

It is important, of course, to know the degree of plastic behavior that may be tolerated, since it is believed that reinforced polyester and epoxy plastics, in general, are subject to this kind of effect to a greater or lesser degree. With our present knowledge, it seems important to obtain good correlations between evidence of plasticity, as given by the creep factor test, and long-time creep to rupture data. The preliminary evidence indicates that such a correlation may exist (see Figure 9). It also seems important to operate reinforced plastic systems at temperatures and stress levels such that any reasonable variation in the curing cycle will not cause difficulty.

The effect of various reinforcements on hysteresis loop areas and modulus has been investigated by Bainton (4-5). Preliminary results show that when hysteresis loop areas are measured on material in the plastic range, substantial increases in loop area are obtained. Consequently, it is believed that fatigue characteristics of reinforced plastics will be adversely affected if operated at temperatures and stresses which induce plastic behavior.

When the part design and nature of the application are such that the properties are dominated by the reinforcement, the creep factor test is not expected to be useful. A convenient example is afforded by unidirectional fiber in pure tension, where the resin has almost none of the load. As the reinforcement goes from unidirectional fiber through the various cloths and into mats and the loading goes from tension through flexure and into compression, the resin component picks up an increasingly greater proportion of the stress. This will have the effect of shifting downwards the whole pattern of stress and temperature at which plastic behavior becomes appreciable.

#Flexural modulus at elevated temperature apparently needs careful definition. These data indicate that it certainly will be a function of the loading rate. We have assumed that it is best represented by deflection at the instant of loading; however, the creep rate is often so high as to require an exact definition of "instant of loading". It has been speculated that the true modulus at elevated temperature is very close to the room temperature value, and the apparent modulus is dominated by a rapid and transient creep phenomenon.

The assumption is made that evidence of appreciable plastic behavior implies risk of failure when either sustained or repeated stresses are involved. Available evidence indicates that once this state is reached, it will rapidly get worse with slight additional increments of stress and temperature. The range of temperature and stresses productive of plasticity may be delineated with the creep factor test. Thus, a system of evaluation is postulated in which operating limits are tentatively set by means of a number of short, simple experiments. Long-time confirming tests may then be run in the most significant region.

Such an evaluation procedure probably will be easier to do with resins of the conventional type which show marked plastic properties at moderate temperatures, and where the upper limit is governed more by plasticity than by thermal deterioration. With the special high-tmperature resins, it is believed hat the degree of cross-linking is such that it will be hard to find much evidence of plasticity before rupture occurs. In any event, the temperatures at which plasticity becomes evident will probably be in the same order as the temperature which will produce marked thermal degradation.

It is also believed that this approach will be less significant for applications which operate near room temperature where high stress is the dominating consideration, and temperature effects are not important. In this case, the shift of hysteresis loop and modulus are more significant. This work strongly suggests the possibility that clear cast resins and thermoplastics may be similarly evaluated by means of short-time creep tests at two temperatures.

Summary

This paper has discussed a simple and rapid method of test which effectively measures plasticity of a reinforced laminate as a function of temperature and stress. The relation of plasticity to resin composition and cure is illustrated in numerous examples. Because of its simplicity, the creep factor test is recommended also as an effective quality control procedure.

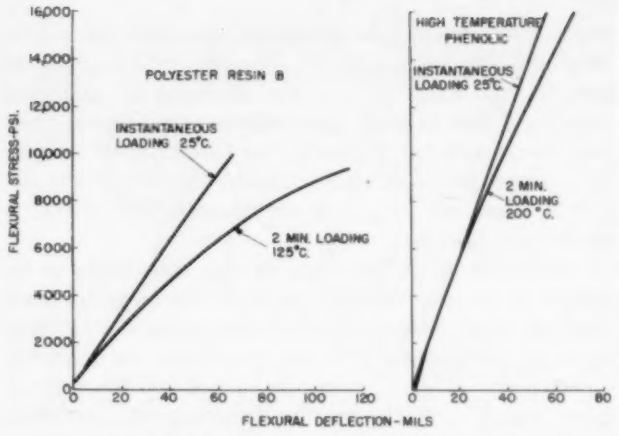


Fig. 16. Comparison of polyester Resin "B," tested at 125° C., with a high-temperature phenolic resin tested at 200° C.

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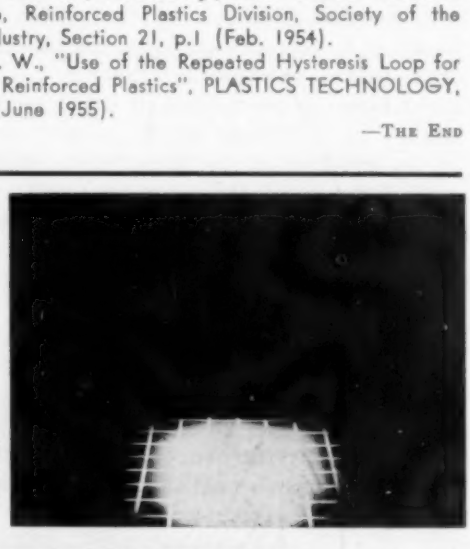
—THE END

Plastic Panels Superior to Glass in Light Diffusion

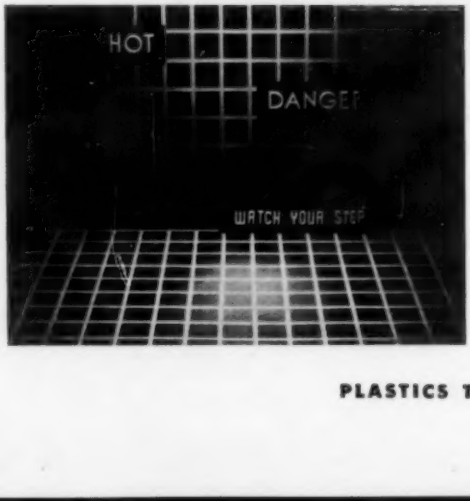
The accompanying, unretouched photographs illustrate graphically the difference between glass and fibrous glass-reinforced polyester panels, when exposed to white light. Both photos were taken of identical setups, using the same camera, film, light source, exposure, and processing time.

Intense light admitted by glass produces glare in a limited area, while surrounding areas remain in shadows. The same illumination passing through Alsynite panels is pleasantly diffused, and converted into effective daylighting.

Alsynite panels are produced by Alsynite Co. of America, San Diego, Calif., in light green, light blue, rose, and clear colors. Darker blues and greens are available to cut-back light and heat. Current sizes range from 12 by 18 to 40 by 80 inches.



Light passing through glass. Note glare and shadows.



Same light source passing through Alsynite panels.

News of the Societies

Optimism Evident at SPI Film and Sheeting Conference

The seventh annual conference of the Plastics Film, Sheeting, and Coated Fabrics Division, Society of the Plastics Industry, Inc., was held on December 4-5, 1956, in the Commodore Hotel, New York City, with 438 persons in attendance. Notable among the registrants was a sober attitude towards the sheet and film industry and its product applications, and a feeling of optimism on the industry's prospects for the coming year.

Despite a slight slackening off from the 1955 records in sales and production, the industry's totals in 1956 were quite high and reflected the earnest efforts of the film processors and suppliers to avoid the misapplications that proved so costly in the past. This concerted drive toward engineering applications is expected to reap dividends in 1957.

The conference consisted of morning and afternoon sessions at which papers were presented; luncheons; and an industry reception following the afternoon session on December 4.

Tuesday, December 4

David Carnegie, Carnegie Coating Co., presided over the morning session at which the following four papers were presented:

"Design for Better Calendering," K. J. Gooch, Farrel-Birmingham Co., Inc. This paper discussed the influences of material type, width, and sheet thickness on calender design, with special emphasis on roll crossing, variable roll friction, and roll crown contour.

"High Speed Milling Test for Measuring Heat Stability of Vinyl Calendering Compounds," G. G. Himmler, Bakelite Co. A test method for measuring heat stability of vinyl compounds was described that is particularly adapted to development and control work. This test is especially effective in measuring the heat stability of non-rigid calendering compounds.

"Trends in the Vinyl Wall Covering Field," Eleanor Pepper, Pratt Institute. Covering the subject of vinyl wall coverings from the design viewpoint, the speaker urged the use of proper design in new patterns, and the abandonment of designs imitating the appearance of fabrics, leathers, and other materials.

"Vinyl Applications in the Luggage Field," E. H. Heitler, Shwayder Brothers, Inc. Vinyl-covered luggage, either plain or laminated, are increasing in popularity with both men and women. Total baggage sales, however, have not kept pace with the increase in travel over the past few years, so the market for vinyl luggage is far from saturated.

K. L. Edgar, Firestone Plastics Co., presided over the luncheon and afternoon session at which the following two talks were given: "How's the Climate?" Arthur Motley, Parade Publications, Inc.; and "Public Relations in the Vinyl Film and Sheeting Industry," G. A. Bowie, Firestone Tire & Rubber Co.

Wednesday, December 5

The following four papers were presented at the morning session, presided over by Stanley Somerville, General Tire & Rubber Co.:

"Rheology of Plastisols," A. C. Werner, Naugatuck Chemical, Division of United States Rubber Co. Viscosity data obtained with a viscometer is capable of covering the entire shear rate range encountered in the vinyl coating process. Use of two viscometers is preferred; one for the low shear end, and the other for higher shear rates. With these viscometers and an understanding of the basic principles of rheology, the spread coating formulator can eliminate much of the guess work from his job and select the ingredients needed for his application without the need for costly plant trials.

"Technology of Adhesives for the Vinyl Industry," R. C. Lillie, Angier Adhesives Division, Interchemical Corp. The adhesives industry has played a major role in recent developments directed toward decorative, structural, and protective applications for vinyl film and sheeting. In selecting an adhesive for a specific application, proper consideration must be given to the type of vinyl film involved and its plasticizer; compatibility of the adhesive to the film substrate and bonding properties; adhesive application method and equipment; and preparation of the surface prior to adhesion.

"Uses, Designing, and Testing of Vinyl Film and Sheeting in the Automotive Industry," Raymond McCullough, Ford Motor Co. The speaker described the applications of vinyl film, sheeting, and coated fabrics in automobiles; design considerations in prospective applications; and methods of testing products to insure their satisfactory performance. These tests include abrasion or wear resistance, cold-cracking resistance, migration of plasticizer, loss of emboss, crocking, tensile strength, shrinkage, sulfide stain resistance, and adhesion.

"The Future of Vinyl in Agriculture," John Murphy, Monsanto Chemical Co. More than 100-million pounds of plastic film have been forecasted for agricultural usage by 1965. Potential applications include economical greenhouse construction, hot bed frames, and seedling beds.

Eli Haddad, Monsanto Chemical Co., presided over the luncheon and the afternoon session, at which the following two talks were given: "Marketing Techniques," William Gove, E.M.C. Recordings, Inc.; and "The Value of Marketing Research to the Vinyl Film and Sheeting Business," Gordon Brown, Bakelite Co. Mr. Brown stressed that marketing research is the basic information on which salesmanship will succeed. Identification and evaluation of the market is needed before the product is offered.

RP Military Specifications

Faster and more accurate development of military specifications calling for reinforced plastics is the objective of a newly-formed group, the Military Specifications Committee of the SPI Reinforced Plastics Division. James S. Lunn, Lunn Laminates, Inc., is chairman of the Committee, whose members include T. B. Blevins, Department of the Army; Dominick Cartolano, Wright Air Force Base; W. B. Curl, Seltu Co.; J. S. Finger; Maurice Martin, Bassons Industries Corp.; R. H. Malamphy, Naugatuck Chemical Division, U. S. Rubber Co.; Herman Reffe, Electro-Technical Products Division, Sun Chemical Corp.; W. B. Wilkins; and C. L. Condit, of SPI. J. B. Alfers, Navy Bureau of Ships, will serve as a consultant to the Committee.

SPE Newark Section

The November 14 program of SPE's Newark Section attracted approximately 100 members and guests to the Military Park Hotel, Newark, N. J. Speakers included Du Pont's Dick Hardesty, who covered "The Effects of Molecular Structure on the Properties of Alathon Polyethylene Resin," and M. H. Straight, Spencer Chemical Co., who explained how "Advertising Puts Money in Your Pocket."

Mr. Hardesty explained the relationships between the molecular structure of branched-chain polyethylenes and important end-use properties. Included here are weight-average molecular weight, number-average molecular weight, number of short-chain branches per 100 carbon atoms, and long-chain branching index. These factors affect melt index and density.

Relationships were expressed as follows: stiffness and yield strength are direct linear functions of crystallinity or density; tensile strength is related inversely to melt index; tear strength is dependent mainly on density; permeability is related inversely to crystallinity; melt index is a convenient measure of processability; film brittleness increases with increasing density and melt index; and stress-cracking is very dependent on melt index and molecular weight distribution.

Over $9-billion was spent on advertising in 1955, according to Mr. Straight, three times the amount spent in 1946. He referred to advertising as "salesmanship with automation," with unit cost of reaching the prospective customer being the important

factor. He felt that plastics advertising had an educational function to perform, since the industry is relatively new and unfamiliar to the lay public. Advertising was further described as a constant, unrelenting pressure which propels goods through the pipelines of American industry.

SPE New York Section

Officers for the coming year have been announced by SPE's New York Section as follows: president, Irvin Rubin, Robinson Plastics; vice presidents George Leaf, Leaf Plastics, and George Lubin, Bassons Industries; secretary, Herb Weber, Rotuba Extruders; and treasurer, George Baron, Ideal Plastics Corp. The new directors are Jerome Bassin, Borden Co.; Arnold Meyer, Bakelite Co.; and Edward Larkin, Monsanto Chemical Co.

SPE Baltimore-Washington

The December 11 meeting of SPE's Baltimore-Washington Section was held at Friendship International Airport, Baltimore, Md. Gordon B. Thayer, Dow Chemical Co. and a member of the Editorial Advisory Board of PLASTICS TECHNOLOGY addressed the group on "Fundamentals of Degradation and Melt Viscosity in Injection Molding."

Degradation results from excessive temperatures or too much oxygen. Compacting the resin granules immediately after they reach the softening stage will reduce degradation, as will a carbon dioxide purge, high-speed operation, streamlining of the cylinder to prevent hold-ups, or the use of uniformly low stock temperatures. Melt extraction heaters are useful, especially with shot sizes up to eight ounces. Their use in preplasticizing can lead to dramatic production rate increases up to 300-400%.

Melt viscosity decreases with increased shear stress, rate of strain, and temperature. Improved moldings can be obtained by reducing temperatures, using molding pressures up to 40,000 psi., and holding the mold-filling time down to 1/100 second. For such rapid fillings, mold evacuation would be required.

SPE Chicago Section

The Chicago Section, Society of Plastics Engineers, Inc., has elected the following officers for 1957: president, Kenneth A. Rouzer, General American Transportation Corp.; vice president, Russ D. Dana, Hercules Powder Co.; and secretary-treasurer, Raymond E. Daniels, Amos Molded Plastics. Directors are William F. Brown, Bakelite Co.; Kenneth T. Dahl, Formold Plastics, Inc.; and Joseph J. Schmidt, Lester Phoenix Die Casting Machines.

The Eastern and Western New England Sections of the Society of Plastics Engineers, Inc., attended a discussion of the All-Plastics House at Monsanto Chemical Co.'s plastics division plant, Springfield, Mass. Shown, left to right are William Wiese, Monsanto; Lew Gustafson, president of the Western New England Section; Ralph Mondano, president of the Eastern New England Section; James Davidson, national secretary of the Society; and Michael Gigliotti, Monsanto Chemical Co.

SPE Newark Section

SPE's Newark Section held its annual Christmas party on December 12 at the Military Park Hotel, Newark, N. J., with more than 180 members and their wives attending. Dinner and dancing were featured, and there were the usual fine table favors for the ladies.

The new Section officers were announced, as follows: president, Robert H. Hoehn, Mack Molding Co.; vice president, John P. Lombardi, Shaw Insulator Co.; and secretary-treasurer, Ernest J. Csaszar, Eagle Tool & Machine Co. and a member of the Editorial Advisory Board of PLASTICS TECHNOLOGY. The three new directors are Norman Brager, Norman Brager Co.; Allan G. Serle, Shaw Insulator Co.; and Albert Spaak, Mastro Plastics Co.

SPI Boston-Providence Chapter

Officers for the Boston - Providence Chapter of the Society of the Plastics Industry during 1957 have been announced as follows: chairman, Arthur A. Staff, Koppers Co., Inc.; vice chairman, William J. Monohan, Seamco Chemical Co.; secretary, Ted Underwood, Standard Tool Co.; and treasurer, Frank Dooley, H. Muehlstein & Co. Directors are James Cushing, Morningstar Corp.; Robert Evans, Farrington Mfg. Co.; and John Adamaitis, Beacon Products Corp.

Detroit Rubber & Plastics Group

The annual Christmas Party of the Detroit Rubber & Plastics Group was held December 7, 1956, at the Sheraton Cadillac Hotel, Detroit, Mich, with more than 1,000 members and guests attending. Officers for 1957 were announced as follows: chairman, H. F. Jacober, Baldwin Rubber Co.; vice chairman, E. J. Kvet, Jr., Detroit Arsenal; secretary, S. R. Schaffer, U. S. Rubber Co.; and treasurer, W. F. Miller, Yale Rubber Mfg. Co.

ASC Polymer Division Head

Thomas G. Fox, director of the polymers research laboratory at Rohm & Haas Co., Philadelphia, Pa., has been elected chairman of the American Chemical Society's Division of Polymer Chemistry for 1957, succeeding Raymond F. Boyer of Dow Chemical Co. A. V. Tobolsky, Frick Chemical Laboratory, Princeton University, was chosen as vice chairman. Secretary-treasurer is F. H. Winslow, Bell Telephone Laboratories.

Author of several papers on polymers, Dr. Fox taught chemistry at Columbia University before serving in the Navy. He was a research chemist at Goodyear Tire & Rubber Co., and a research associate at Cornell University before joining Rohm & Haas in 1950. Dr. Fox is a member of the American Physical Society, and is chairman of its Division of High Polymer Physics.

News of the Industry

SPI Production Figures for 1956 and Estimates for 1957

Domestic production of plastic and resin materials in 1956 reached a new high of more than four billion pounds, according to estimates by the Society of the Plastics Industry, Inc., New York, N. Y. Total 1956 production was approximately 4,112,900,000 pounds, an increase of 10% over 1955. SPI estimates that 1957 production will be approximately 5% higher than 1956, or about 4.3-billion.

Last year also established the plastics industry as a $2-billion industry for the first time. The value of its products in 1956 are estimated by SPI at approximately $2,056,450,000. Estimates for 1957 call for a 5% increase to $2,150,000.

The plastics industry, as a whole, operated at capacity in 1956. Estimated outputs of some plastic materials, and percentage changes from 1955 figures, are as follows: polyethylene, 541,128,000 pounds (up 30%); polyesters, 71,800,000 pounds (up 30%; vinyls, 729,500,000 pounds (up 10%); styrenes, 636,000,000 pounds (up 4%); phenolics and other tar acid resins, 503,000,000 (approximately no change); ureas and melamines, 312,000,000 pounds (approximately no change); and cellulosics, 140,000,000 pounds (down 10%).

Sales statistics compiled by SPI indicate that molders and extruders, as a group, had an approximate increase in business last year of 6% over 1955; thermosetting molders had a 10% increase in business in 1956, while thermoplastic molders found their business off slightly. Moldmakers enjoyed increasing business over the last few months of 1956 which brought their sales to about 16% above 1955 totals. In view of the time lapse between making a mold and putting it into production, this is a favorable sign for increased production of molded parts this year.

In replies from 235 member companies to an SPI questionnaire covering all branches of the plastics industry throughout the United States, 56 stated that their current business was excellent; 154 firms said "fair"; and 16 companies said "poor." When asked "What do you anticipate for the first six months of 1957?" the replies were as follows:

	Higher	About the Same	Lower
Sales	160	64	10
Profits	108	88	36
Size of work force	114	115	5
Wage rates	147	83	0
Prices	64	155	15
Material costs	82	138	12

Of the repliers, 188 said that current collections were good, while 88 claimed they were slow. Working capital was said to be adequate by 194, inadequate by 38. Asked if they planned to expand, 152 said yes and 77 said no.

Indicated expansions in 1957 ranged from 5-100%. Molders indicated planned expansions at the lower end of this scale, with the majority at no more than a 10% increase in capacity. Most reinforced plastics manufacturers plan to increase production capacity, with one company indicating an expansion of 250%. Generally high expansion plans also were indicated by extruders. The over-all pattern for the entire plastics industry, however, indicates an average expansion of 5% over 1956.

Reinforced Plastics Division

The Society's Reinforced Plastics Division reports that sales in 1956 gained 30% over the preceding year, and predicts an equal percentage growth this year. More important than volume, in the opinion of industry leaders, is the entry of reinforced plastics into new markets and the growing number of structural and semi-structural components in building and all forms of transportation. Of equal importance is the widening manufacturing base provided by the entrance into the field of compression molders and established manufacturers.

The growth of the reinforced plastics industry is traced to improvements in processing techniques, better surface finishes of parts, and increased understanding of the design and use flexibility of the materials. The processing advances include faster curing resins, new types of compounds, and better materials handling methods. In this respect, the development of premix compounds has made possible the injection and compression molding of reinforced plastics. The improvement in surface finish of molded parts has resulted from the use of better reinforcing mats, overlay mats, veils, and fillers.

The current production volume and the future potential for reinforced plastics in the automobile and appliance fields can be ascribed to their ability to be formed in large, one-piece units (with attendant savings over multi-part production and assembly), and the use of less costly tools in the forming operation. The consensus of opinion is that the aircraft, furniture, building, automotive, appliance, and electrical fields hold great promise for reinforced plastics.

Company Year-End Reports and 1957 Forecasts Optimistic

Year-end reports and predictions for 1957 from the materials supplier companies in the plastics industry are unanimous in expressing their gratification with the record production and sales totals established in 1956, and in predicting that the high level of business will continue this year. Highlights of some company reports are given below:

Bakelite Co.

In his statement, George C. Miller, president of Bakelite Co., noted that the spectacular increase of about 45% in sales (poundwise) of polyethylene played a major role in the record output of plastic materials in 1956. Polyethylene's sales increase from 346-million pounds (in 1955) to 500-million pounds was the outstanding feature of the year. Application gains were scored in jacketing and insulation for wire and cable; pipe; molded housewares; packaging; and various construction and agricultural uses.

The vinyls remained the largest of the plastic groups, Miller pointed out, reaching a total sales of about 700-million pounds last year, an increase of about 6% over 1955 figures. Aside from a significant broadening in plastisol and organosol usage, there was no single factor to account for the increase. Leading the application field for vinyls were sound recordings, floor tiles, coated cloth, electrical insulation, and coating emulsions.

The styrene family was the second largest plastic materials sales group in 1956, reaching an estimated sales total of 590-million pounds. This total showed very little change from the preceding year, but there were shifts in applications. Polystyrene lost some ground to polyethylene in the housewares field, but this was compensated for by increases in high-impact styrene for toys, radio cabinets, and refrigerator liners.

Year-end totals for phenolics, melamines, and ureas were about the same as for 1955, Miller stated. The future for reinforced plastics appears bright, especially in structural applications. New applications such as women's shoe heels and increased activity in packaging helped the cellulosics field, but the alkyd and coumarone-indene groups were down slightly from 1955 levels.

Speaking of prospects for the future, Miller said that total industry productive capacity for high-pressure polyethylene should reach the 900-million pounds per year level by mid-1958, and new plants for low-pressure polyethylene will bring a total industry capacity of some 850-million pounds per year by 1960, thus indicating that the days of polyethylene shortage are over for some time to come. Total domestic annual output of polyethylene, therefore, should be 1,3-billion pounds within the next three years. There is also some reason to think that both the low- and high-pressure processes will be able to produce resins of almost identical specifications.

Catalin Corp.

Company sales in 1956 set a new record of about $25-million, according to Harry

Krehbiel, president of Catalin Corp. of America. He forecast a further increase of about $5-million in 1957. In reviewing the past year, Krehbiel placed special attention on advances in resorcinol adhesives which have made use of laminated timers in construction. Continuing and expanded research will lead the way to new uses for Catalin products and better, more economical manufacturing processes for current and projected products.

Celanese Corp.

Highlights of 1956 for the plastics division of Celanese Corp. of America was the start of commercial production of Fortiflex polyolefin, according to Bjorn Andersen, company vice president and general manager of the division. Full-scale production at an annual rate of 40-million pounds is expected early this year at the new plant in Houston, Tex. Sales of Celanese plastic products in 1956 were the highest on record, and 1957 sales are expected to achieve further gains.

Increased production of acetate film and sheeting barely enabled the company to keep up with increasing demand, Andersen noted, and Celanese plans to expand output at its Newark, N. J., plant. This demand stemmed from significant gains in requirements for recording tape, pressure-sensitive tape, produce pre-packaging, optical frames, transparent packages, and inserts for wallets and photo albums.

New applications for acetate molding materials in 1956 resulted in greater demand. If forecasts for both acetate and propionate demand prove accurate, new records for both materials are expected to be set this year, Andersen concluded.

General Tire

The current plastics boom will result in 1957 sales exceeding $85-million for General Tire & Rubber Co.'s plastics division, said M. G. O'Neil, executive assistant to the president. He also predicted that the company's over-all sales this year will reach a record high of $425-million, as compared with about $370-million in 1956. General expects to further expand its PVC resin plant in Ashtabula, O., this year, and 1957 will see the full integration of all the company's plastics divisions with Ashtabula as the prime source of raw material, O'Neil declared.

Goodrich Chemical

An $11-million expansion program highlighted B. F. Goodrich Co.'s operations during 1956, according to John R. Hoover, president. A major part of this expansion is taking place at the Avon Lake, O., facilities where vinyl resin production is being doubled and development laboratories are being increased. This work is expected to be completed by March 1957.

Sales in 1956 featured diversification in applications of the company's products. Vinyl resins found increasing use in building and construction, wire and cable, flooring, extrusions, foam, and pipe. Associated chemical companies outside the United States showed encouraging growth, particularly British Geon; Geon do Brasil; Geon de Mexico; Japanese Geon; and B. F. Goodrich Canada. The latter firm's new plastics plant near Welland, Ont., is scheduled for start-up early this year.

Reichhold Chemicals

In his year-end report and industry forecast for this year, Henry H. Reichhold, president of Reichhold Chemicals, Inc., said that he was more optimistic about the future than at any other time since RCI was founded three decades ago. Sales volume of the company's domestic plants reached about $60-million last year, and a conservative estimate for 1957 predicts a 10% overall increase. New plastic homes will be one of the developments that will expand the plastics and chemical industries from 15-25% during the next year, and triple the volume within the next five years, Reichhold declared.

After reviewing the past growth of the plastics industry, the company president said that consumption of plastic materials will grow to five or six billion pounds per year by 1960. The chemical industry anticipates that fully 15% of its sales in 1960 will be of products not even being made today.

West Coast Firm Moves East

A well-known extruder and compounder of vinyls, Resin Industries, has opened a plant in Leominster, Mass., and a sales office in Stamford, Conn. The firm, a subsidiary of Borden Co., virtually duplicates its West Coast operation in Santa Barbara, Calif.

The new plant has over 21,000 square feet of working space which will be devoted to the production of specialized and custom extrusions, plus the compounding of PVC resins and copolymers. Quality control laboratory facilities will be installed, and initial production is presently under way. The Connecticut sales office will be under the direction of Allan W. Stephens, who previously managed eastern sales from the Santa Barbara headquarters.

UCC Basic Research Institute

The Union Carbide Research Institute for basic scientific research will be built on the corporation's Westchester property near Tarrytown, N. Y. Scheduled for completion by Spring of 1958, the facility will include 40 laboratory modules separated by movable partitions to facilitate the changing of space requirements.

Dr. Augustus Kinzel, vice president in charge of research, will administer the affairs of the Institute, and E. R. Jette will serve as director. A major purpose of the Institute will be to study the chemical and physical behavior of matter under ordinary and extreme conditions of

Artist's conception of UCC Research Institute.

pressure and temperature. A scientific library and office space will be provided.

Diamond-Shaped Molding Powder

Careful study by Du Pont's polychemicals department reportedly has established the diamond shape as the most effective for use in plastics extrusion and injection molding. The new design for Lucites 129, 130, and 140 has the slanting shape of a parallelogram about ⅛-inch long and ⅛-inch thick.

Appearance was not the only reason for selecting the diamond-cut particle. Lucite diamonds have approximately 10% higher bulk density than cube-cut powder, thus permitting 275 pounds of material to be loaded in a conventional 250-pound drum. Closer packing of particles carries over into the machines themselves, and hoppers have slightly greater capacities. Additional advantages include improved pouring, easier loading of pneumatic hoppers, and better metering into processing machines.

The new cut has a lower moisture content, and the material can be processed at higher temperatures without bubbling or splay in molded parts. Prior tray drying is obviated, and hopper drying is suggested only as a precautionary measure. The virtual absence of fines promotes freedom from discoloration in severe heating cycles.

Extrusion Corporation Formed

A new company, Dyfoam Corp., has been formed to engage in the continuous extrusion of Dylite expandable polystyrene, a product of Koppers Co., Inc. Employing a new process developed in Sweden by Isoleringsaktiebolaget, W.M.B., the firm will supply extruded sheets or slabs in varying thicknesses, densities, and lengths.

Dyfoam has leased a modern plant at New Castle, Pa., containing over 36,000 feet of work space. It is anticipated that demands for the material will warrant the construction of an additional plant during 1957. Steps are being taken to set up a distributor organization, and channel some of the production into new end-uses.

Employing the new process, Dyfoam

(Continued on page 50)

open and shut case

for **BUTYRATE**

Sloane Manufacturing Co. has found several clear-cut advantages in producing new low-pressure valves of versatile Tenite Butyrate. This tough plastic is free from attack by rust and resists the corrosive action of many chemicals. Therefore, the plastic valve seat never becomes roughened from corrosion—the cause for so many leaky metal valves. Open, the Butyrate valves permit a smooth flow unimpeded by rust build-up. Closed, they give a positive seal. There are no washers to replace. What's more, since the valves are transparent, flow can be readily observed.

Speedy connections to Butyrate plastic pipe can be made by simply brushing matching surfaces of valve and pipe-end with solvent cement before joining. The valves are also available with threaded ends for use with conventional metal pipe carrying cold or mildly warm liquids.

Users find that Tenite Butyrate has high impact strength and stands up well under a wide range of weathering conditions. That's why this Eastman plastic has been used through the years for so many products that demand rugged strength, better performance, and longer life. An illustrated booklet describing Tenite properties and uses is yours for the asking. Write for a copy today to EASTMAN CHEMICAL PRODUCTS, INC., subsidiary of Eastman Kodak Company, KINGSPORT, TENNESSEE.

● Information regarding Tenite also can be obtained from local representatives listed under "Plastics—Tenite" in the classified telephone directories of the following cities: Atlanta, Chicago, Cleveland, Dayton, Detroit, Houston, Kansas City, Leominster (Mass.), Los Angeles, New York City, Portland (Ore.), Rochester (N.Y.), St. Louis, San Francisco, Seattle and Toronto—elsewhere throughout the world, from Eastman Kodak Company affiliates and distributors.

Valve molded of Tenite Butyrate by Sloane Manufacturing Co., 12270 Montague St., Pacoima, California.

TENITE
BUTYRATE
an Eastman plastic

1932 – EASTMAN'S 25TH YEAR IN PLASTICS – 1957

reportedly can produce the lightest rigid-insulation material currently available, with a density as low as 0.9 pound per cubic foot, and a K-factor of 0.25. Trade-named Dyfoam, the material is marketed in two-foot widths, thicknesses of ½-10 inches, and in any desired length.

Completes Epoxy Facilities

Shell Chemical Corp. has announced the completion of two new Epon epoxy resin units at its plant in Houston, Tex. The move is expected to triple the firm's epoxy production. One of the units will produce liquid-grade resins; the other, solid grades.

Liquid resins are manufactured in three different end-forms for use by the automotive and aircraft, structural materials, corrosion-resistant paints, and metal-to-metal adhesives industries. They are also used in the production of corrosion-resistant piping and tanks, and for electrical insulation.

Solid grades are employed primarily in the surface coatings industry. The new unit boosts the company's production by 2½ times, and has multiplied the batch size ten-fold. This latter feature should substantially reduce laboratory control test costs.

Enters Plastic Pipe Field

A West Coast manufacturer of extruded plastic products and custom extrusions, Marken Plastics Corp., Los Angeles, Calif., has entered the plastic pipe field with a full line of both rigid PVC and flexible polyethylene pipe and tubing. A complete range of sizes from ⅜-4 inches, with fittings, is available.

Marken also will maintain a sales engineering department to assist distributors and users in developing new applications for the piping. Technical service information will be available on corrosive installations.

Makray Manufacturing Expands

Makray Mfg. Co., custom plastics molders, has moved into a new, one-story plant at 4400 North Harlem Ave., Chicago, Ill. Originally a tool and die manufacturer, the firm branched into custom and contract plastic molding shortly after World War II. The new unit consolidates scattered facilities into a unified operation.

Over 60,000 square feet of manufacturing and warehouse space are available, including an air-conditioned office area, tool and die facilities, and lunch room. The company makes its own molds, and currently has 26 high-speed presses.

In Brief . . .

Riverdale Color Co., Inc., Newark, N. J., has moved into larger facilities at 5 Oliver St. The move coincides with the development of new laboratory methods for compounding polystyrene and polyethylene colors.

Insular Chemical Corp., has commenced vinyl resin production at its new plant in Hicksville, N. Y. The firm is jointly owned by Rubber Corp. of America and the Ross & Roberts division of Pollak Industrial Corp.

Columbian Carbon International de Mexico, S. A., has been formed as a wholly-owned subsidiary of Columbian Carbon Co. The new form will handle the sale of carbon blacks and iron oxides in that country. Address is Coahuila 233, Mexico 7, D. F.

Elmer E. Mills has opened a plastics consulting office at 135 S. LaSalle St., Chicago 3, Ill. Mr. Mills has been associated with plastics manufacturing for approximately 30 years, having operated his own custom molding shop.

Carpenter Steel Co.'s Alloy Tube division, Union, N. J., has announced price reductions up to 15% on all types of rigid, unplasticized PVC pipe and fittings.

General Tire & Rubber Co.'s Pennsylvania division has announced price increases ranging from 5-10% on vinyl coated fabrics. Higher labor and raw material costs were cited as reasons for the price boost.

Smith Chemical & Color Co., Brooklyn, N. Y., has been appointed exclusive representative for Magnesiet-En Amaril-Fabrieken of Vlaardingen, Holland, in the United States. M. A. F. is the largest and oldest European manufacturer of Magnesite, including crude ore and calcined grades.

Columbian Carbon Co., New York, N. Y., has opened a third plant for manufacturing carbon black colloidal dispersions. Located in Tacony, Pa., the new unit will supplement that of plants in Easton, Pa., and Toronto, Ont.

Lowell Technological Institute has received an appropriation of over $2-million for the erection of a four-story electronic and plastics engineering building. The new unit will house the general engineering laboratories.

The Rainville Co. of California, Alhambra, Calif., has been formed, with Arthur Rainville as president. Mr. Rainville has been acting as representative of Rainville Co., Inc., since its inception four years ago. The firm specializes in the sale of machinery for the plastics industry.

Guild Electronics, New York, N. Y., has stocked all components to service all heat-sealing equipment on the market. Guild's line is known as Dynatherm.

Goodyear Tire & Rubber Co., has commenced production of injection-molded polyethylene heel bases at its Windsor, Vt., plant. Called Jetlite, the new product is lighter than conventional heel bases, and takes a better finish.

Fiberfil, Inc., Warsaw, Ind., has announced the completion of phase two of its manufacturing expansion program. The firm produces glass-reinforced injection molding compounds.

Rainville Co., Inc., has opened a district office at 3105 N. Cicero Ave., Chicago 41, Ill. Myron C. Borovik has been named district manager.

Decorator Plastics Co., Toledo, O., has announced the availability of six-inch reference discs molded of Barrett's Plaskon urea compound. Intended to serve as plastic color "swatches," the discs are marketed in the 36 different House & Garden colors for 1957.

Gaylord Plastics, Inc., has moved to a larger plant at 1643 South 19th St., Santa Monica, Calif. The former address was 2121 E. Sepulveda Blvd., Los Angeles.

Hoover Color Corp., has moved its New York sales and administrative offices to 13 Cordier St., Irvington, N. J.

Farrel-Birmingham Co., Inc., has established a sales office at Piazza della Republica 32, Milano, Italy. Sergio F. Tomassini, former director and works manager of S. A. Luigi Pomini, will direct the operation.

Catalin Corp. of America will construct a $500,000 laboratory in Fords, N. J., for the production of special chemicals.

News from Abroad

Tenth Anniversary for Delft Research Institute

The Plastics Research Institute T.N.O., Delft, Holland, which has just celebrated its tenth anniversary, can look back on a period of rapid expansion during which it has become one of the most important sections of the well-known Netherlands Organization for Applied Scientific Research (T.N.O.). Officially established in September 1946, it started with a staff of about 10 which has grown to almost 180. To these may be added the 55 persons engaged in basic research on high polymers at the T.N.O. Central Laboratory, a new independent off-shoot of the Institute's scientific department.

Designed primarily to serve the Dutch plastics industry, the Plastics Research Institute acts as information center and consulting body and, when necessary, undertakes research and development work for the industry. It also maintains close contact with foreign manufacturers and organizations in the plastics field.

The Institute's technological department conducts research sponsored by industry, as well as original research on materials and methods. It has a well-equipped experimental laboratory and pilot plant where development work on glass-reinforced plastics is performed. The advisory and documentation section of the Institute collects general information on all aspects of plastics and allied materials; issues the periodical, *Plastica;* and organizes plant tours, courses, and lectures. Because of the considerable interest shown in its work, the testing and analysis department, which is responsible for work on standardization of plastics products, also has shown substantial progress and development.

European Injection Machines

There is a growing trend among European manufacturers of machinery to build ever larger injection molding machines which seems to be motivated, at least in part, by a desire to meet the challenge of the vacuum forming method for producing large parts. F.I.M.S.A.I., of Milan, Italy, recently showed its new 6000A machine which is believed to be the largest in Europe. It has a stated capacity of 6,000 grams (about 13.2 lbs.), but actually can handle up to 8,000 grams (17.6 lbs.) producing such large parts as wash bowls, sinks, refrigerator linings, kitchen furniture, and the like, with a work cycle of 60 seconds.

The machine is equipped with the patented "Hydro Block" mold closing system, having a locking pressure of 2,126 tons. The injection system includes a patented pre-plasticizer which is provided with a feed screw turning in a cylinder heated externally by a series of electrical resistances. This screw is driven by an electric motor through a speed reducer. The material is forced into the injection chamber by a plunger pressure of 238 tons. The machine is 2.40 meters wide (about 94 inches), 11.50 meters long (about 42 feet), 3.5 meters high (about 11½ feet), and weighs about 55 tons.

The French firm, Jean Facon & Cie., Paris, has produced an injection molding machine which some claim to be the most powerful in Europe and probably in the world. This unit has a capacity of about 5½ pounds (polyethylene), hopper capacity of 3.5 cubic feet, total injection pressure of 350 tons, and locking pressure of 1,500 tons. It is 6.10 meters long (about 20 feet) and 3.50 meters high (about 11½ feet). With this machine, two large jugs can be made in a single injection cycle of less than three minutes. The mechanism for opening the mold acts in two directions: horizontally, by means of a classic toggle joint system; and vertically, with movement controlled by a system of Galle chains above two brackets supporting the upper mold half. Thus, by judicious combination of two partial movements, a mold can be opened in any direction. This machine, by the way, is equipped with the automatic feed-metering and pressure-compensating device described on page 756 of our November 1956 issue.

Transfer Decorating Process

Under the name of Plasdekal, a German firm is marketing a newly developed multicolor transfer paper for decorating surfaces of thermoplastic articles made from PVC, vinylidene chloride, acrylates, PVA, etc. The process is said to be suitable also for use with thermoplastic lacquers.

With Plasdekal, the design is printed on a thin paper backed with a special separating preparation, and is transferred to the object to be decorated by heating. This can be either high-frequency or thermal-impulse heating under pressure, if necessary, or by a heated calender at temperatures between 90-130° C., depending on the softening point of the plastic. After the design has been transferred in this way and the article cooled, the paper can be stripped off easily. The design also can be transferred in a molding press, or by cold-fixing to the article by a suitable plastics solution. In the latter case, the paper can be removed easily after evaporation of the solvent.

A special thermoplastic printing medium is used for the design on the paper, and only those colors are included which are insoluble in plasticizer and resist acids, alkalies, soaps, and soda. Light-fastness of the colors is said to range from good to excellent and, since there is no plasticizer in the thermoplastic printing ink, there can be no exudation or migration of plasticizer during the heating process.

The Plasdekal method is claimed to be simpler than the usual methods of printing with colors which frequently do not adhere properly and do not resist scraping off. When done properly, the new process is claimed to give clear, sharply defined pictures and designs in colors which are fused to the base and resist scraping.

German Injection Machines

The Branch Association for Rubber and Plastics Processing Machinery of the V.D.M.A., has compiled data showing the number of injection molding machines that have been supplied to the German plastics industry by domestic manufacturers of machinery from 1946 to 1955, inclusive. The figures given in the table below do not include machines exported by German manufacturers, nor foreign machines imported into West Germany.

Year	Up to 100 g. Shot Weight	Over 100 g. Shot-Weight	Machines, Total
1946	2	—	2
1947	15	1	16
1948	69	1	70
1949	133	10	143
1950	139	40	179
1951	243	60	303
1952	412	83	495
1953	546	145	691
1954	523	132	655
1955	571	160	731
	2,653	632	3,285

If the number of machines made before 1944 and still in use (estimated at around 500) and the machines imported or built by the plastics manufacturers themselves are added to these totals, it is seen that the equipment of the German plastics industry at the end of 1955 included about 3,860 injection molding machines.

Polypropylene in Germany

A German firm has reportedly been experimenting for some time with the production of polypropylene, and a pilot plant with daily capacity of 100 kilograms is expected to be started shortly. These amounts will be distributed among certain research organizations and manufacturers in order to gain more experience on processing conditions, physical properties, and fields of application. The material is said to lend itself to the production of foils as well as of fibers resembling wool. These fibers will not be used in clothing for the present at least, but will be used only for industrial purposes.

Names in the News

Nelson V. Seeger

Nelson V. Seeger has been named to the newly-created post of associate director, exploratory research, for Diamond Alkali Co., Cleveland, O. Dr. Seeger will be responsible for the firm's development and research activities in monomer, polymer, and radiation chemistry. He had been serving as research chemist with Goodyear for the past 16 years.

Paul J. Flory, professor of chemistry and acting chairman of the department of chemistry at Cornell University, has been named to head Mellon Institute's investigational activities as executive director of research. The post has been established since the recent retirement of **Edward R. Weidlein** as president.

E. J. Mills, Jr., has been assigned to a newly-created staff position at the South Charleston, West Va., plant of Carbide & Carbon Chemicals Co. He will be concerned with special technical assignments and the recruitment of technical personnel. **L. F. Theiling** and **V. T. Stack** have been appointed group leaders within the plant's development department.

Frederic S. Dawn has joined the technical staff of Decar Plastic Corp., Middleton, Wisc., as laboratory director. The firm is engaged in the manufacture of plastic laminates, primarily for the furniture industry.

William D. Price has been appointed representative for Automatic Molding Machine Co., Los Angeles, Calif., in North and South Carolina, and Eastern Tennessee.

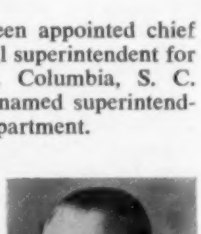
Eugene Sinnett has been appointed plant manager of L.O.F. Glass Fibers Co.'s Corrulux division, Houston, Tex. He formerly served as production superintendent at the plant in Parkersburg, W. Va.

Giffin D. Jones has been appointed director of Dow Chemical Co.'s physical research laboratory at Midland, Mich. He succeeds **W. C. Bauman,** who was recently named director of research for the company's chemicals department. Dr. Jones had been assistant to Dr. Bauman.

G. J. Crowdes has been appointed district manager of Dennis Chemical Co.'s Ohio office. He will direct operations in that State, Pennsylvania, New York, and Michigan. Dennis manufactures plastisols, specialty coatings, and adhesives in St. Louis, Mo.

Robert F. McAuliffe has been appointed technical representative for Bakelite Co.'s molding materials division. He joined the firm in 1953, and recently was separated from the U. S. Air Force.

D. W. Weber has been appointed chief engineer and mechanical superintendent for Southern Plastics Co., Columbia, S. C. **E. M. Staub** has been named superintendent of the extrusion department.



Alden R. Ludlow, Jr.

Alden R. Ludlow, Jr., has been appointed sales director of U. S. Industrial Chemicals Co., a division of National Distillers Products Corp. A 20-year man with U.S.I., Mr. Ludlow has been manager of alcohol sales for the past 10 years. He succeeds **Lee A. Keane,** who has retired after 30 years of service.

C. W. Blount has been appointed vice president in charge of marketing, and **J. D. Benedito** has been named vice president in charge of sales for Bakelite Co. Mr. Blount joined the firm in 1924 as a sales engineer, and has served as assistant sales manager, vice president and general sales manager, and vice president in charge of sales. Mr. Benedito joined Union Carbide in 1935, and has been serving as general sales manager for Bakelite since early last year.

Pittsburgh Studio

Gordon B. Thayer

Gordon B. Thayer has been appointed plastics specialist for Dow Chemical Co.'s plastics technical service. He served six years with the Saran development laboratory, and has headed-up that service's molding section for the past nine years. Mr. Thayer is a member of PLASTICS TECHNOLOGY's Editorial Advisory Board.

Leonard F. Swec has been appointed laboratory manager of W. R. Grace & Co.'s polymer chemicals division technical service department in Clifton, N. J. He previously served as development manager for Standard Packaging Corp., and as technical director of the H. P. Smith Paper Co.

Lee F. Samler, technical director of National Plastic Products Co., has been appointed vice president and general manager of Saran Yarns Co., Odenton, Md. The latter company is owned jointly by Dow Chemical Co., and National Plastic Products. Mr. Samler will retain his old position in addition to assuming the new duties.

James J. Odom, Jr., has been appointed director of technical service at Reichhold Chemicals' Tuscaloosa, Ala., plant. He previously served as district sales manager in New Orleans, and as research engineer with National Gypsum.

Edward J. Massaglia has been elected president of Thermaflow Chemical Corp., Wilmington, Del., a subsidiary of Atlas Powder Co., also of Wilmington. **Robert P. Barnett** will serve as secretary, and John B. Capella will be treasurer. Mr. Massaglia also is general manager for operations of the parent company's chemicals division.

Frederick A. Riehl has been appointed technical representative for the calendering materials division of Bakelite Co. in the Boston district. He succeeds **Donald E. Bisgrove,** who has been transferred to the Clifton, N. J., sales district.

Edward E. Heck has been named vice president of Artag Plastics Corp., Chicago, Ill., replacing **LeRoy T. Kinder.** He previously served as chief engineer at Santay-Sinko, as Chicago technical service manager for U. S. Rubber Co., and as plant manager for Republic Molding Corp.

Carbide & Carbon Chemicals Co., New York, N. Y., has announced the following four transfers of technical representatives from the home office: **R. T. Blake** to the Cleveland district office; **J. T. Ferguson** to the New York district office; **L. C. Kranefuss** to Detroit; and **M. M. Maupin** to Houston.

James M. Martin and **William F. Christie** have been appointed sales representatives for Escambia Chemical Corp.'s plastics division. Mr. Martin will service the New England area; Mr. Christie, the Middle Atlantic States.

David L. Grimes

David L. Grimes has been named president of Narmco, Inc., San Diego, Calif. He has been serving as vice president, and as general manager of Narmco Industries.

S. Sydney Minault has been elected vice president of National Research Corp., Cambridge, Mass. He joined NRC in 1953, and has been serving as general manager of the equipment division for the past two years.

James G. Felsenthal has been elected to the board of directors of G. Felsenthal & Sons, Inc., Chicago, Ill. Mr. Felsenthal has been with the firm for the past 10 years, and has been serving as corporate secretary and assistant sales manager.

Carbide & Carbon Chemicals Co., New York, N. Y., has announced the following reassignments within its sales department:

J. W. Nagel as Seattle district sales manager

A. L. Merker as Philadelphia office manager

F. R. Amport as Cleveland technical representative

D. J. Primavera as Boston technical representative

J. D. Burger as New York supervisor

C. W. Spagnulo as Newark technical representative

J. E. Sullivan as Cleveland technical representative

M. G. Fielder as Miami technical representative

R. W. Halley as Los Angeles technical representative

D. J. Kelly as Baltimore technical representative

D. E. Francisco as sales control worker.

Clarence D. Bucher has joined Falls Engineering & Machine Co., Cuyahoga Falls, O., as Western sales and service representative. He served with Dayton Rubber Co., for the past 14 years, most recently as director of purchases.

Al Magida has been appointed district sales manager for Alsynite Co. of America in New York and New England. For the past four years Mr. Magida handled military sales for Gemsco, Inc.

William L. McIntosh has been appointed assistant district sales manager of Du Pont Co.'s film department in New York, and **John A. Pie** will serve the same function in Chicago. Mr. McIntosh had been selling in the Chicago district; Mr. Pie, in Philadelphia.

William J. Rothfuss has been named general manager, equipment division, for the Cryovac Co., a subsidiary of W. R. Grace & Co. He is succeeded as manager of the Cedar Rapids, Ia., plant by **William J. Seidel,** former plant superintendent. Mr. Rothfuss will maintain headquarters in Cambridge, Mass.

Daniel D. Lewis has been appointed sales manager of Durable Formed Products, Inc., New York, N. Y. He will continue to service metropolitan New York, Northern New Jersey, and Southern Connecticut.

Robert C. Myers has been appointed manager of packaging sales for Du Pont's film department, succeeding the late **Warren J. Harte. William B. Davis,** assistant industrial sales manager since 1952, succeeds Mr. Myers as industrial sales manager. **Carl H. Schreep** has been named manager of the Western industrial sales district, with headquarters in Chicago. **Ronald C. Davis** becomes manager of the Eastern district; headquarters being set-up in New York City.

Leonard Bogen has been made vice president of Southern Plastics Co., Columbia, S. C. **Herman Clark** becomes supervisor of compression molding and fabrication; **Paul M. Branham** has been appointed supervisor of the finishing department; and **Paul R. Hair** has been named chief inspector and supervisor of quality control.

A. K. Thorn, former manager of American Management Association's packaging division, has been appointed Western regional sales manager for Plax Corp., Hartford, Conn.

J. B. Chip has been elected vice president in charge of sales for Plastic Material Sales, Inc., a subsidiary of Plastic Molders Supply Co., Inc., Fanwood, N. J.

Hall Gentry Studio

Charles M. White

Charles M. White has been named to manage the new Dallas, Tex., sales office of Godfrey L. Cabot, Inc., Boston, Mass. Former engineer with Hood Rubber Co., Mr. White has been a member of Cabot's Chicago sales staff for the past three years.

Gordon H. Lovett has been appointed technologist at Monsanto Chemical Co.'s plastics division engineering department in Texas City, Tex. He previously served as an engineering supervisor.

Donald R. Butler has been appointed manager of Vlchek Tool Co.'s plastics division, Cleveland, O. Carl Towne has been named assistant superintendent of plastics production.

G. J. Williams

G. J. Williams has been appointed to the newly-created post of assistant to the sales manager of Dow Chemical Co.'s plastics department. Former sales manager of the textile fibers department, he will handle staff and administrative responsibilities. Mr. Williams is succeeded in his old post by **Amos L. Ruddock,** who had been head of the plastics sales merchandising section for the past 10 years.

John F. Blais has been appointed marketing manager of Catalin Corp. of America, a newly-created staff position. Mr. Blais served 18 years with American Cyanamid Co.'s plastics division, and for the past three years has operated his own plastics and paper-consulting office.

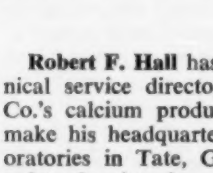
Leonard Seglin has been named manager of engineering development for Food Machinery & Chemical Corp.'s new organic chemicals division, New York, N. Y. Mr. Seglin previously served with Ethyl Corp., and with FMC's Westvaco division. His latest position was supervisor of process engineering for the combined chemical divisions group.

Roy S. Fisher

Roy S. Fisher has been elected vice president and director of sales for National Vulcanized Fibre Co., Wilmington, Del. Before his appointment as manager of sales in 1955, he served as manager of the Cleveland-Pittsburgh-Cincinnati territory for more than 24 years. Mr. Fisher joined the firm in 1923.

Robert F. Hall has been appointed technical service director of Georgia Marble Co.'s calcium products division, and will make his headquarters at the central laboratories in Tate, Ga. A production and paint chemist since 1937, Mr. Hall was formerly associated with Garland Co. and United Co-operatives, Inc.

John K. Whittaker has been elected vice-president in charge of sales for Modigliani Glass Fibers, Inc., New York, N. Y.



Jean Raeburn, N.Y.

Richard W. KixMiller

Charles F. Beran has retired as a director of Celanese Corp. of America, after 33 years' association with the company. He is succeeded by **Richard W. KixMiller,** vice president in charge of the chemical division.

E. Russell Ashley has been elected executive vice president and director of Electromold Corp., Trenton, N. J. The founder and former president of Ashley-McCormick Co., he will direct the administrative and sales functions.

Robert Jack Manning has been named product manager for Du Pont's new Delrin acetal resin. **Edwin H. Keller** replaces him as marketing manager for Tynex nylon monofilament.

Donald H. Getz has joined the polymer chemicals division of W. R. Grace & Co., as senior process engineer in its technical department, Clifton, N. J. He previously served with G-E's plastics group, and with Foster Wheeler Corp.

D. M. Young has been appointed associate technical director of Union Carbide Development Co., and will represent the firm in Geneva, Switzerland. Dr. Young joined the parent organization in 1936, most recently serving as assistant to the director of research for Carbide & Carbon Chemicals Co.

George Magnus and **Everett Mailey** have joined the development department at the South Charleston, W. Va., plant of Carbide & Carbon Chemicals Co.

Gordon V. Gorecki has been named market development supervisor for Minnesota Mining & Mfg. Co.'s reinforced plastic pipe. He has been with the firm since 1944, serving as technical service engineer, and market supervisor for industrial trades tapes.

Henry H. Reichhold was elected president of Reichhold Chemicals, Inc., White Plains, N. Y. **Charles J. O'Connor** was named chairman of the board, and **Albert G. Goetz** becomes vice chairman.

Clifford W. Brown has been elected president of Narmco Resins & Coatings Co., Costa Mesa, Calif. He formerly served as vice president and general manager.

George B. Croft has been appointed Western sales manager for Automatic Molding Machine Co., Los Angeles, Calif. Mr. Croft had been serving as general manager of the Nathan R. Smith Mfg. Co., custom molders, for the past ten years. He will direct all sales activities west of the Mississippi River.

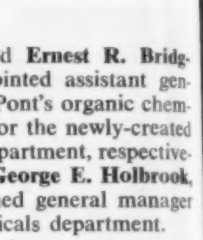
A. W. Downes has been appointed general manager for new resins and compounds at Bakelite Co., New York, N. Y. Former associate director of development, Dr. Downes will assist in coordinating and expediting all activities in new product development. **A. A. Boehm,** former production superintendent at the Bound Brook plant, becomes general manager of phenolics. **C. M. Blair, Jr.,** superintendent at the Carbide & Carbon Chemicals plant in Seadrift, Tex., has been appointed general manager of all polyolefin activities. **J. E. Brister** has been named general manager for polystyrenes. He formerly served as manager of the molding and extrusion department. **R. D. Glenn,** former assistant works manager for Carbide & Carbon Chemicals, has been named general manager for vinyls.

Louis C. Goode has been appointed manager of the Moundsville, W. Va., plant of Allied Chemical & Dye Corp.'s National Aniline division, succeeding the late **Ross M. Sims.** Prior to his new appointment, Mr. Goode was supervisor of the firm's Azoics division.

Henry S. Winnicki

Henry S. Winnicki, former director of engineering and development for Food Machinery & Chemical Corp., becomes president and manager of the firm's newly-created organic chemicals division. The new division will handle the manufacture and sale of all FMC plastics and organic chemicals which are not directly linked with other chemical division activities.

William C. Kay and **Ernest R. Bridgwater** have been appointed assistant general managers for Du Pont's organic chemicals department and for the newly-created elastomer chemicals department, respectively. Dr. Kay succeeds **George E. Holbrook,** who was recently named general manager of the elastomer chemicals department.



Path Bros., N.Y.

Ivey Allen, Jr.

Ivey Allen, Jr., has been appointed research coordinator of Bakelite Co., and will direct the combined efforts of the research department and the product development section. Dr. Allen has been with the firm since 1929, and has held the position of superintendent of research for the past five years.

OBITUARY

John F. Shea

John F. Shea, vice president in charge of sales for the Becco Chemical division, Food Machinery & Chemical Corp., died November 26 at the Roswell Park Memorial Institute in Buffalo, N. Y., after a prolonged illness.

Mr. Shea was born in Fitchburg, Mass., in 1905. He received his technical education at Lowell Textile Institute, and joined Becco in 1930 as a field representative. From manager of the New England sales territory, Mr. Shea was promoted to company sales manager. He was elected vice president in 1955.

Burial was in Newton, Mass., where Mr. Shea had made his home for many years

New Materials

Write item numbers on Readers' Service Card to obtain more information.

Polyester-Glass Mat Laminates

Three grades of polyester resin-glass mat laminates featuring dimensional stability, high impact strength, and arc resistance have been placed on the market by National Vulcanized Fibre Co. Mat impregnation is accomplished with a liquid polyester containing inorganic fillers and a catalyst, and cure is effected under low pressure.

GP-9100 is a general-purpose, medium-cost sheet with good electrical and mechanical properties. GP-9104 is a low-cost grade with lower mechanical properties than GP-9100, and having fair electrical properties. GP-9202 is a flame-resistant grade with the best electrical properties of the three, except for arc resistance.

Applications for the laminates include fabricated containers, cams, armature slot wedges, spacers, switchboard panels, and arc chutes. Standard sheet sizes are 32 by 36 inches, 32 by 48 inches, and 32 by 74 inches. Properties are reported as follows:

	GP-9100	GP-9104	GP-9202
Color	Tan	Light Cream	Dark Cream
Flexural strength, lengthwise, psi	26,000	20,800	29,800
Crosswise, psi	22,800	20,200	22,000
Impact strength, lengthwise, ft.lbs./in.	11	9	10
Crosswise, ft.lbs./in.	10	8	9
Bond strength, lb.	1,000	1,200	1,200
Hardness, Rockwell M	98	98	108
Dissipation factor, 1 megacycle	0.013	0.012	0.011
Dielectric constant, 1 megacycle	4.4	4.78	3.97
Dielectric strength, parallel to laminations, Kv	52	57.5	51
Perpendicular to lamination, volts, mil	400	475	500
Insulation resistance, megohms x 10^6	1	1	1
Arc resistance, arcs	88	96	3
Water absorption, % gain	0.21	0.31	0.14
Density	1.75	1.82	1.79

Readers' Service Item M-1

Polyurethane Release Agents

Two releasing parchments for polyurethane foams have been introduced by Paterson Parchment Paper Co. Designated Patapar Releasing Parchments 35-22T and 55-41T, the parchments differ in their basis weight, surface characteristics, and releasing ability.

Both papers are said to release readily from cured foam, imparting a smooth, satin-type finish. Patapar 55-41T, being heavier and stronger, is intended for continuous foaming machines where the paper must withstand certain mechanical handling. The other parchment works well on tray operations.

Physical and performance properties are reported as follows:

	35-22T	55-41T
Surface	Smooth	Glossy
Flexibility	Fair	Very good
Printability	Excellent	Fair
Wetting	Poor	Poor
Resistance to oil and plasticizers	Good	Good
Contamination	None	None
Color	White	Light blue
Elongation, %:		
Machine direction	1.5	1.5
Cross direction	10	9.5
Tensile strength, psi.:		
Machine direction	30	42
Cross direction	20	30
Width, max., in.	66	60
Square yds./lb.	9.5	5.4
Caliper, in.	0.0025	0.003
Basis weight, 500 sheets, 24 x 36 in., lbs.	35	62

Readers' Service Item M-2

Epoxide Casting Resin

An epoxide casting resin which can be used at temperatures as high as 600° F. has been developed by Emerson & Cuming, Inc. Designated Stycast 2662, the resin pours readily and cures at low temperatures. Shrinkage is reported to be negligible.

Supplied as a free-flowing liquid, Stycast 2662 is used in conjunction with the firm's Catalyst 14. Cured material is black, and has a heat distortion temperature in excess of 500° F. It is especially effective for electronic embedments, as a high-temperature sealer or adhesive, and as a surface coating.

Following are physical and electrical properties reported for the material:

Specific gravity	1.2
Flexural strength @ 70° F., psi.	14,500
At 300° F., psi.	10,700
Flexural modulus @ 70° F., psi. x 10^6	0.65
At 300° F., psi. x 10^6	0.43
Impact strength, ft. lbs./in. notch	0.44
Coefficient of thermal expansion per °C.	28 x 10^{-6}
Water absorption in 24 hrs., % gain	0.1
Dielectric constant at 60 cps., 70° F.	3.9
Dissipation factor at 60 cps., 70° F.	0.008
Dielectric strength @ 70° F., volts/mil.	420
At 300° F., volts/mil.	370
Volume resistivity @ 70° F., ohm-cm.	10^{16}

Readers' Service Item M-3

High-Density Ethylene Polymer

Fortiflex A, an ethylene polymer produced catalytically by a low-temperature, low-pressure process, is currently available from Celanese Corp. of America in molding pellet form. A highly-crystalline material, it is similar in many respects to conventional polyethylenes, though possessed of greater rigidity and resistance to heat and chemicals.

The improved properties of Fortiflex A result from the process of manufacture, whereby long, straight-chain polymers are produced. This decrease in branching gives a high-molecular-weight material which is both hard and rigid. Physical data are reported as follows:

Melt index	0.6
Density, gms./cc.	0.96
Water absorption in 24 hrs., ⅛-in. specimen, %	0.01
Brittleness temperature, °F	—180
Heat distortion temperature, °F	194
At 264 psi., °F	124
Softening temperature, °F	260
Impact strength, ft.lbs./in. notch	4-10
Compressive strength, 5% offset, psi.	5,300
Flexural strength at break, psi.	6,600
Flexural modulus, psi. x 10^5	0.17
Tensile strength at yield, psi.	3,900
Tensile elongation, %	250
Hardness, Shore D	60

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Mold shrinkage, ASTM tensile bar, in./in.	0.04-0.06
Dielectric strength, short time, volts/mil.	510
Dielectric constant, 1 kc.	2.35
At 1 mc.	2.35
Dissipation factor, 1 kc.	0.0002
Volume resistivity, ohm-cm. x 10^{15}	6

Readers' Service Item M-4

Conductive Surface Coating

A colloidal dispersion of metallic copper in lacquer, designed to provide a highly-conductive surface coating, has been introduced by Acheson Colloids Co. Designated 'dag' Dispersion No. 235, the material is reported to be especially effective in printed circuitry, electroplating of non-conductors, radar equipment, hearing aids, and electronic measuring devices.

The dispersion is said to be considerably cheaper than silver paint and more easily applied than copper foil. Application is by spray or brush, with dilution in the ratio of two parts dispersion to one part thinner for the spray method. Only slight dilution should be made for brushing. The resultant film air-dries, and can be handled within a few minutes. Adhesion can be enhanced by mechanical pre-treatment, where necessary, of the surface to be coated.

Spray applications give a film thickness of approximately 0.0005-inch per pass at the above-suggested dilution. The lowest resistance is obtained by applying multiple layers rather than a single thick coating. A resistance of about six ohms per square inch is typical for a 0.001-inch film.

Properties of the dispersion include total solids content of 66% by weight; density of 14.5 pounds per gallon; flash point of 21° F.; covering power of about 45 square feet per pound; and shelf life of at least six months.

Readers' Service Item M-5

Vinyl Polymerization Catalyst

A wet form of benzoyl peroxide, packed in polyethylene-lined paper bags, has been introduced by Cadet Chemical Corp. for sale through McKesson & Robbins, Inc. Containing approximately 20% water, this polymerization catalyst for vinyls is not shock sensitive, flows freely, and disperses quickly.

Both the safety feature and the convenience would seem to indicate its replacing the dry and paste forms in many applications. Moisture content is standardized within ±5% limits, and each package contains the equivalent of one pound dry weight. Gross weight has been reduced about 10% from the paper cartons normally used, and cubic measurement has been reduced almost 30%.

Cadet benzoyl peroxide is still classified as a flammable solid, and should be kept away from heat, sparks, steam pipes, radiators, and other sources of heat. Molecular weight is reported at 242.2, and melting point is 104-105° C.

Readers' Service Item M-6

High Density Polyethylene

High-density (0.935-0.94) polyethylene molding materials are presently available in commercial quantities from Spencer Chemical Co. Called Poly-Eth Hi-D, the series features higher heat resistance, less permeability, improved rigidity, and better tensile properties. Other characteristics include high-gloss finish and resistance to surface abrasion.

Data are reported as follows:

Density	0.935-0.94
Nominal melt index, gms./10 min.	1
Ultimate tensile strength, psi	2,400
Yield tensile strength, psi.	2,400
Elongation, %	425
Stiffness @ 73°F., psi.	35,000
Hardness, Shore	D 56
Softening point, Vicat, °F.	235
Brittleness temperature, °F.	—100
Impact strength, Izod notched, 73°F., ft. lbs./in.	Did not break
Power factor	0.0003
Dielectric constant	2.3

Readers' Service Item M-7

High-Purity Solvent-Reagent

A certified, reagent-grade dioxane for use in plastics research, testing, and processing has been placed on the market by Fisher Scientific Co. Called Ultra-Pure Dioxane D-11, the material serves as a solvent for cellulose acetate, ethyl cellulose, benzyl cellulose, resins, oils, waxes, oil- and spirit-soluble dyes, and many other compounds.

Each lot is individually analyzed; however, specifications governing all lots are as follows:

Water, %	0.025
Peroxides, %	0.003

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We like to concentrate our efforts—and don't you, too? That's why, instead of scattering limited lots of our remarkable GREX resin in sample quantities—blunderbuss fashion—we're taking *time* to develop and pinpoint the production and marketing data we believe you are entitled to have *before* you embark on the brand-new fields GREX promises to open for you. It's an exciting promise . . . but we won't resort to a blunderbuss technique to achieve it. GREX is well worth the wait!

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POLYMER CHEMICALS DIVISION

W. R. GRACE & CO.

Carbonyls, %	0.004
Iron & heavy metals, %	0.0001

The material is particularly useful in analytical work where low iron and low peroxide are desirable. Quart and gallon sizes are available.

Readers' Service Item M-8

Dispersant for Emulsion Paint

A non-ionic dispersant for PVA, acrylic, and butadiene-styrene paints has been introduced by Air Reduction Chemical Co. under the tradename Surfynol TG. The material is said to increase hiding power, promote greater color development, improve color uniformity in brush-out, lower foam formation, and provide better shelf stability.

Physical properties of Surfynol TG are reported as follows:

Form	Liquid
Activity, %	83
Freezing point, °C.	0
Boiling point, °C.	250
Water solubility, wt. %	0.5
Specific gravity, gm./ml.	1
Weight per gallon, lbs.	8.3
Surface tension, 0.1% aqueous solution, dynes/cm.	27.6

Readers' Service Item M-9

Epoxy Splash-Coat Powder

A white powder which mixes readily with water to form a hard, water-resistant face coat for plaster patterns and splash casts has been introduced by Furane Plastics, Inc. Named Epocal, the coating composition is prepared by the addition of five parts by weight of Epocal to one part by weight of water. Slightly less Epocal is used if the material is to impregnate hemp pads or ties.

Epocast epoxy resins can be cast or laminated against an Epocal splash coat, and backed up with gypsum-impregnated hemp fiber pads to make an entire model or mold. Release agents or a polished wax surface must be employed to obtain permanent-type molds. A face coat about ¼-inch thick is said to add unusual strength to a plaster mold or model. The pot life of Epocal after the addition of water is approximately 10-15 minutes.

Readers' Service Item M-10

Three Chemical Intermediates

Three polyglycols, adaptable as chemical intermediates in the manufacture of polyurethanes and surfactants, have been introduced by Dow Chemical Co. Polyglycol 166 is a polyepichlorohydrin, available in average molecular weights of 450, 900, and 1,150. Polybutylene is marketed with average molecular weights of 500, 1,000, 1,500, and 2,000; and Polyglycol 174 comes in average molecular weights of 500 and 750.

Properties for the first-mentioned grade in each of the above materials are reported as follows:

	Polyglycol 166	Polybutylene	Polyglycol 174
Specific gravity	1.299	0.974	1.136
Refractive index	1.49	1.449	1.635
Viscosity @ 100°F., cks	344	49	10,833
At 210°F., cks.	12.5	5.35	32.2
Viscosity index	25	3	....
Hydroxide content by acetylation, %	7.29	....	6.41
Color, APHA	200	30	200
Four point, °F.	21	—10	75
Flash point, °F.	450	420	430
Fire point, °F.	475	445	465
Chloride content, %	21.7	....	....
Surface tension, dynes/cm.	30.2	....	....

Readers' Service Item M-11

VANSTAY Z

zinc bearing chelator for PVC resins imparts outstanding clarity, stability and resistance to sulfur staining when used as recommended with other VANSTAYS in many vinyl products.

Plastisols, Organosols, Extruded Goods

Use 1.5 VANSTAY R with .5 VANSTAY Z for maximum resistance to process heat and good service life.

Film, Sheeting, Molded Products

Use 1–1.5 VANSTAY HT with .5–1.5 VANSTAY Z to obtain the required protection.

When Roll plating is a problem:

Use 1.5 VANSTAY N with 1.5 VANSTAY Z as the stabilizing system.

Our Technical Service Representatives will gladly demonstrate the merits of our materials in your plant and assist in solving production problems.

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New Equipment

Write item numbers on Readers' Service Card to obtain more information.

Sieburg's Tensilkut Model II cutter.

Tensile Specimen Die-Cutter

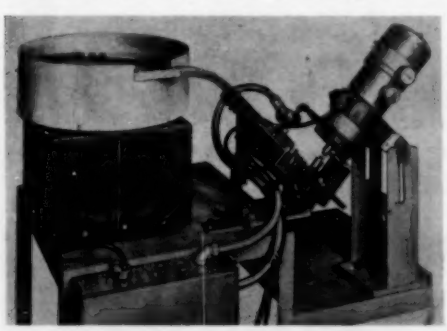
A portable machine for the cutting of tensile specimens from non-metallic sheet and plate materials has been placed on the market by Sieburg Industries, Inc. Designated Tensilkut Model II, the unit will cut specimens of 0.0005-0.5 inch in thickness, accurately machined to ASTM specifications.

A variety of materials can be cut, including ½-mil paint films, polyethylenes, acrylics, and fibrous glass-reinforced polyester laminates. A precision master template controls specimen tolerances. No heat is evolved during cutting, since speeds of 20,000 rpm. can be reached. Size of the unit is 14 by 18 by 14 inches, and it weighs 49 pounds. A one-hp. AC-DC motor with wired footswitch operates the cutter.

Readers' Service Item E-1

Automatic De-Burring Machine

Machines designed to automatically deburr metallic and non-metallic parts are available from Klaas Machine & Mfg. Co. Built to specifications, the units select workpieces from a hopper and carry them up a track defective to the fixture, while defective parts are rejected. There, the parts are tapped, drilled, or otherwise machined.



Klaas' automatic de-burring machine.

The original unit was designed to remove burrs from molded plastic discs on washers. This was done at the rate of 300 per hour, as opposed to 60 by manual operation. The hopper feeder positions the part so that the face to be machined is upward. From the feeder, the piece goes through an escapement to an air-operated vise which holds the piece for de-burring. A drill head feeds, machines, and detracts. Chamfering tools can be adapted to the drill head.

The standard unit is two feet square, and four feet high. Other sizes are available for different specifications.

Readers' Service Item E-2

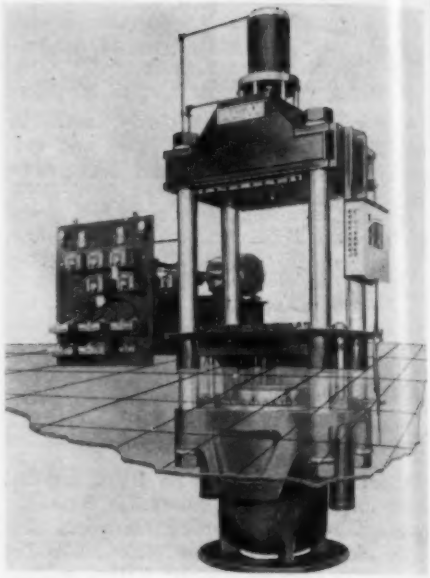
Diamond-coated band saw blade being used to cut Pyrex glass.

Diamond-Coated Saw Blade

A diamond-coated blade, which can be installed in any band saw machine without modification of the rollers or guides, has been placed on the market by Dia-Chrome Co. The blades are available coated on all sides, or with the leading edge coated and ⅛-inch return on both sides. Widths are either ½- or ⅜-inch.

The diamond-coated blades are reportedly ideal for cutting reinforced plastics, glass, ceramics, transite, asbestos, and mica. Using 80-mesh diamond grit, the blades are capable of cutting through 4¼-inch Pyrex glass at the rate of 12 inches in 25 minutes.

Readers' Service Item E-3



Erie Engine's 314-ton compression-transfer molding press.

Transfer Molding Press

A 314-ton capacity press, designed for straight-compression and transfer molding jobs, has been developed by Erie Engine & Mfg. Co. The press is equipped with a self-contained hydraulic pumping unit, which consists of a variable-volume, pressure-compensated, radial piston-type pump connected directly to a 25-hp. motor. Both the hydraulic unit and the motor are mounted on a 100-gallon reservoir.

When used for straight-compression molding, the operator sets the pressure, opening and closing speeds, and the cycle control (this includes automatic degassing, if required). Automatic features are also used for transfer molding. The operator depressed the "Transfer Start" button, and the press and transfer cylinder contact the limit switches to bring about a slower closing speed. Return speed of the transfer cylinder and opening speed of the press are so synchronized that the former returns to the upward position before the press opens. When the bolster contacts the lower limit switch, all circuits are de-energized. The press has two pull-back and two knock-out cylinders.

The following specifications are reported for the press:

Working area, in.	36 x 36
Hydraulic pressure, psi	2,000
Ram diameter, in.	20
Travel, in.	21
Strain rod diameter, in.	4-5.5
Opening & closing speeds, rapid travel, in./min.	50-300
Slow travel, in./min.	1-10
Transfer cylinder bore, in.	8
Cylinder capacity, tons	50
Transfer stroke, in.	12
Cylinder pull-back, tons (each)	15
Knock-out, tons (each)	10
Knock-out stroke, in.	3

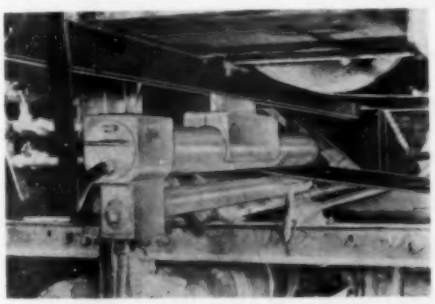
Readers' Service Item E-4

Beta-Ray Thickness Gages

A series of instruments for the measurement and control of sheet thickness has been placed on the market by Isotope Products, Inc. By measuring the amount of beta radiation which passes through moving sheet material, the instruments detect, record, and control the basis weight and thickness of films and coatings. Thallium, strontium, and cerium radiation sources are used.

The Betameter is equipped with a strip-distributed radiation source to provide average sample measurement, thus minimizing the effect of point variations. A monorail mount enables the instrument's head to be transversed to any desired position across the width of the stock being measured. Betameters are available in models which are tailor-made for the plastics industry. Special, wide-range, and multi-range gages are engineered to the wide range of stock thicknesses encountered in calendering, as well as special "calender" heads. Any range of plastic sheet thickness can be accommodated, from the thinnest up to 0.39-inch.

Exclusive with the Betameter is the "null-balanced operation," by which the small signal from the detector is balanced against an identical signal from a second source and detector inside the instrument. The difference is amplified to record the amount of "off weight" from the desired



Betameter being used to measure sheet thickness.

standards. Decay of radiation source and the effects of air pressure and temperature are automatically cancelled out.

Another adaptation, the Betamatic, is used for automatic control. Air or electrical control systems can be used. The coating gage has its measuring head mounted opposite the coated stock, and the balancing head is mounted opposite the uncoated stock. The recorder indicates the weight of the coating directly, and automatic roll screw-down motors control the actual coating thickness applied.

Readers' Service Item E-5

Four Small-Size Batch Ovens

Four, junior-size utility ovens for batch drying, curing, baking, processing, and testing are presently available from New

Small-size utility batch oven.

England Oven & Furnace Co., Inc. External dimensions of the ovens are 24 inches square by 34 inches high. The inside lining is Armco aluminized sheet steel, and the bottom drip pan is two inches above the floor.

A forced air recirculation system is maintained within the oven chamber through the use of a fan and controlled intake and exhaust vents. A shielded heating element prevents radiant over-heating, and helps to maintain a more even temperature control throughout the chamber.

Model CA-250 has a temperature range to 250° F., and an internal working space measuring 22 by 20 by 23 inches. Heat generated is 2,000 watts, and power supply required is 110 volts. Models CA-650 and CA-550 have internal working spaces of 20 by 17 by 22 inches, and temperature ranges of 100-650° F. and 100-550° F., respectively. Heat generated is 3,500 watts, using a 220-volt power supply. Model CA-1000 has a temperature range of 100-1,000° F., and a working space measuring 18 by 15 by 21 inches. It generates 5,000 watts on 220 volts.

Readers' Service Item E-6

Beta-Radiation Gage Series

A new series of non-contact thickness gages for the continuous measurement and production control of paper, plastic, rubber, foil, coatings, and laminates has been introduced by Nuclear Corp. of America, Inc. Designated Atom-At, the series includes the following five types: the basic Transmission gage for sheet materials; the Backscatter gage for measuring one-side coatings; the Differential gage for measuring coatings on thin materials; the Multiple-Head Transmission gage for wider specimens; and the Transverse Profile portable gage which measures thickness across the entire width of a sheet.

Basically, an Atom-At gage consists of a source of radioactive material; an ionization chamber; and an indicating, controlling, and recording console. Radioactivity from the source passes through the sheet material and is detected by the ionization chamber. This signal is then amplified in the console and read on two meters; a weight (thickness) meter which records on a custom-calibrated scale, and a light-heavy meter which expands a portion of the other scale to show precise deviations of actual weight from nominal weight.

Plastic films and sheets, 0.2-50 mils in thickness, can be measured at speeds up to 3,500 feet per minute. Production control can be regulated to better than 1% of the nominal weight or thickness, and maximum sensitivity is 0.4% of the nominal weight or thickness for one scale division. Overall stability of the system is better than 1% over a 24-hour period.

Atom-At beta gage and recording console.

Readers' Service Item E-7

Two-Ounce Injection Press

A two-ounce, fully automatic injection press of vertical design has been placed on the market by the plastics division of F. J. Stokes Corp. Designated Model 701, the machine features vertical clamping with a horizontal combing action. It molds, degates, ejects, and sorts automatically; even to diverting sprues and runners to separate bins.

Following are specifications reported for the unit:

Minimum molding cycle, positive ejection, sec. 6.5
Dry cycle, positive ejection, sec. . 3.5

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for the Vinyl Plastic and Coating Industries

In these five Standard Units are all the necessary components to control effectively the degradation mechanisms that take place in polyvinyl chloride resins on aging, during heat processing or on exposure to sunlight. They are widely used alone and in combinations for specific effects in clear and opaque stocks. Their advantages have been proven over other tested materials, such as those based on tin (which frequently decolorizes effects of degradation without correcting them) or on lead (which frequently contributes to oxidation and breakdown on aging). We also supply combinations of components selected from these five Standard Units, to correct special conditions encountered in each Vinyl Processing Industry.

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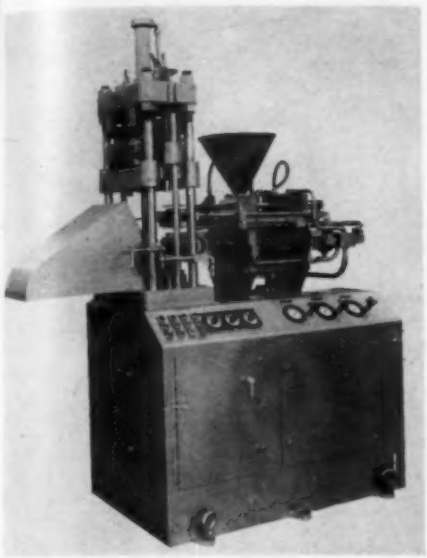


Stokes Model 701 injection molding machine.

Minimum molding cycle, air ejection, sec.	4.5
Dry cycle, air ejection, sec.	1.5
Injection pressure, psi.	11,300
Plasticizing capacity, lbs./hr.	30
Clamping capacity, tons	50
Stroke, in.	5.5
Daylight opening, in.	17-23
Molding area, in.	8 x 11
Maximum hydraulic pressure, psi.	1,000
Motor, hp.	7.5
Cylinder heaters, watts	2,500
Floor space, in.	39 x 66
Height, in.	97
Net weight, lbs.	4,500

Readers' Service Item E-8

Plastic Hose Clamps

One-piece hose clamps for PVC, polyethylene, and stainless-braided plastic hose have been placed on the market by Circle Clamp Corp. Affixable in three seconds with ordinary pincers, the clamp is reportedly 70% cheaper than either the nut-and-bolt or the flat-band clamps previously available.

The clamps are circular in shape, and have two or three U-shaped folds or lugs depending on diameter. Slipped on the hose, the clamp is crimped in place by squeezing together the parallel sides of the lugs. For removal, the lugs are snipped off with pincers.

Carbon Plastics Corp., uses the clamps on its plastic hose, which is designed to handle everything from air to highly concentrated acids. Pressures up to 1,800 psi., are involved. Circle clamps are available in 20 sizes ranging from ¼-2⅝ inches in inside diameter. Larger sizes are made to specification.

Readers' Service Item E-9

Gas-Fading Test Chamber

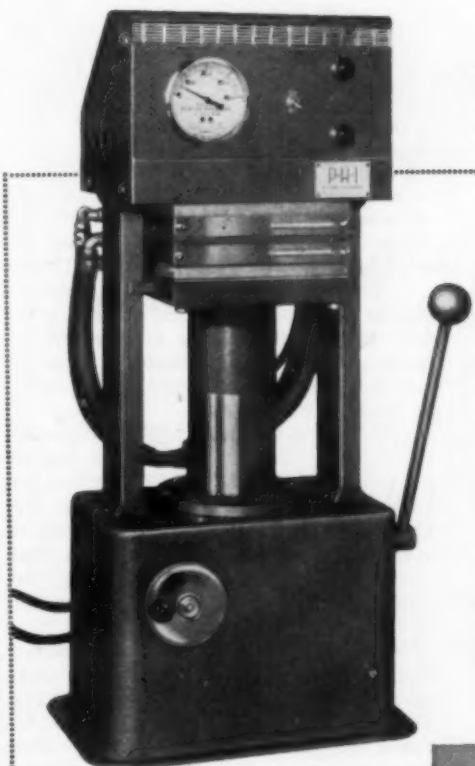
An instrument for the evaluation of atmospheric gas reactions on dyed materials is being manufactured by United States Testing Co. Known as the Gas Fading Chamber, the unit is available in two models: the Drum Type, and the more compact Squirrel Cage.

Both test chambers feature corrosion-resistant chambers, stainless steel housings, dial thermometers, motor and light switches, self-sealing closures, and exhaust vents. By introducing special valve ports into the main supply line, it is possible to mix and feed controllable quantities of different gases into the chamber. Automatic rotation of samples assists gas circulation and brings about uniform exposure conditions. Interior lighting permits observations to be recorded during the actual testing.

The Drum Type chamber is 26 inches in diameter and 40 inches high. The Squirrel Cage Type is 15 inches wide, 12 inches deep, and 28 inches high. Both operate on 110-volt, 60-cycle, A.C. power supply.

U. S. Testing's Squirrel Cage Type Gas Fading Chamber.

Readers' Service Item E-10



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New Products

Write item numbers on Readers' Service Card to obtain more information.

Mylar conveyor belt resists doughnut grease.

Polyester Film Conveyor Belt

A food-conveyor belt, fabricated by joining two sheets of Du Pont's Mylar polyester film with a special white adhesive, has been placed on the market by Mohawk Supply Co. The belt is said to provide smoothness, strength, flexibility, freedom from cracking, non-absorbency, heat transference, resistance to lubricants, and both temperature and humidity resistance.

The smooth surface of the belt imparts a glossy appearance to the bottoms of chocolates, while simultaneously cooling their coated centers. Mylar is resistant to cocoa butter, making it effective for plaques that convey candies on trays through multi-tiered coolers.

Belting is easily installed. The lamination of three-mil transparent sheets is left open at the end for a few inches, and dovetailed when fitted to the conveyor. Pressure sensitive tape with a backing of Mylar completes the over-all smooth finish.

Goldenberg Candy Co., reports that two enrober tunnel belts, measuring 32 inches by 128 feet, have been subjected to a continuous temperature since October 1955 without losing their high gloss. In addition, the belts were found to have a service life 1½ times that of conventional belting.

Readers' Service Item P-1

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Reinforced Plastic Ladder

A lightweight ladder utilizing sandwich construction of glass fibers and American Cyanamid's Laminac polyester resin has been developed by Putnam Rolling Ladder Co. Combining the superior strength-to-weight ratio of lightweight metal ladders with the non-conducting qualities of dry wood ladders, the new ladder is ideal for use in power and electrical work under all weather conditions.

One of the toughest and most durable ladders ever constructed, it can support the weight of two men after a section has been removed from one side rail. The fibrous glass-reinforced Laminac is molded over a balsa wood core to form the sides, and aluminum or magnesium rungs are plastic-welded to form an integral part of the ladder.

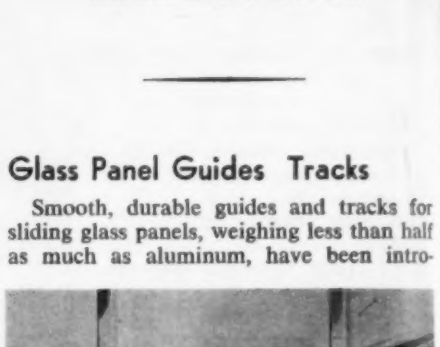
Over 650 pounds resistance to rotation in the side rail has been reported, using an applied torque of 718 pound inches. The ladder withstood 120,000 volts between the rungs without breaking, when tested under conditions of 50% relative humidity. Ladders are available with either straight or tapered sides. Sizes range from 8-20 feet in standard or heavy-duty single ladders, and 16-28 feet in standard extension ladders. Heavy-duty extension ladders can be obtained in lengths of 16-40 feet. Approximate weight is two pounds per foot.

Non-conducting, reinforced plastic ladder.

Readers' Service Item P-2

Glass Panel Guides Tracks

Smooth, durable guides and tracks for sliding glass panels, weighing less than half as much as aluminum, have been introduced by Engineered Products Co. Consisting of hard, gray vulcanized fiber, the tracks and guides have excellent shock resistance, close-tolerance machinability, sound-insulating qualities, and resistance to wear, corrosion, and rust.



Double-grooved track of vulcanized fiber.

Vulcanized fibers are converted cotton cellulose with a tough, dense structure. A low-cost material, it has good mechanical and dielectric strength. A minimum Rockwell hardness rating of R-50 makes it possible to use carbon-tipped tools for machining and polishing. Tolerances of 0.005-inch can be held with $11/64$-inch track grooves. Other properties reported for the material are a tensile strength of 6-8,000 psi., a compressive strength of 20,000 psi., and a flexural strength of 6-14,000 psi. Friction coefficient is only 0.16 for fiber on fiber, and 0.21 for fiber on aluminum.

The solid fiber tracks are made in four-, five-, and six-foot lengths, with single or double grooves. Beveled sliding surfaces further reduce the possibility of friction.

For neater appearance, extruded aluminum tracks with fiber inserts are available.

Readers' Service Item P-3

Bumper pads of polyurethane foam weigh but 35 pounds.

Polyurethane Bumper Pads

Millions of miles of newsprint reportedly are being saved every year through the use of Flex-O Bumper Pads, a product of Biltrite Sailmakers. They consist of canvas-covered, tapered polyurethane foam; the latter being supplied by American Latex Products Corp., under the trade name Stafoam.

Bumper pads utilizing nearly every known type of filling have been used as a protection for the 1,800-pound newsprint rolls during loading and unloading. Some were effective in cushioning the crushing impact of such tremendous weights, but of themselves, weighed so much that they required two men for their positioning. Flex-O pads weigh but 35 pounds.

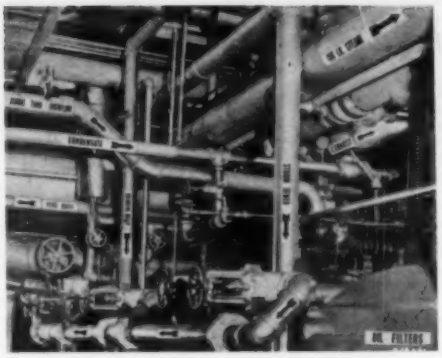
"Slow memory" Stafoam takes up to 180 seconds in returning to its original shape, an ideal factor for bumper-pad use. Their wedge shape provides perfect landing platforms on which to topple the bulky rolls without damage to the edges. The material is impervious to weather, acids, and oils.

Readers' Service Item P-4

Self-Adhesive Pipe Markers

Pipe identification is easily standardized with W. H. Brady Co.'s self-adhering Perma-Code pipe markers. Made from vinyl-impregnated cloth, the markers are then coated with silicones to assure long life. The built-in adhesive carries a two-year guarantee.

Black letters on ASA Standard A-13 background colors identify pipe contents with both color and legend, so that tracing pipe lines through different rooms is quick and sure. Matching-stock directional arrows indicate the direction of flow.

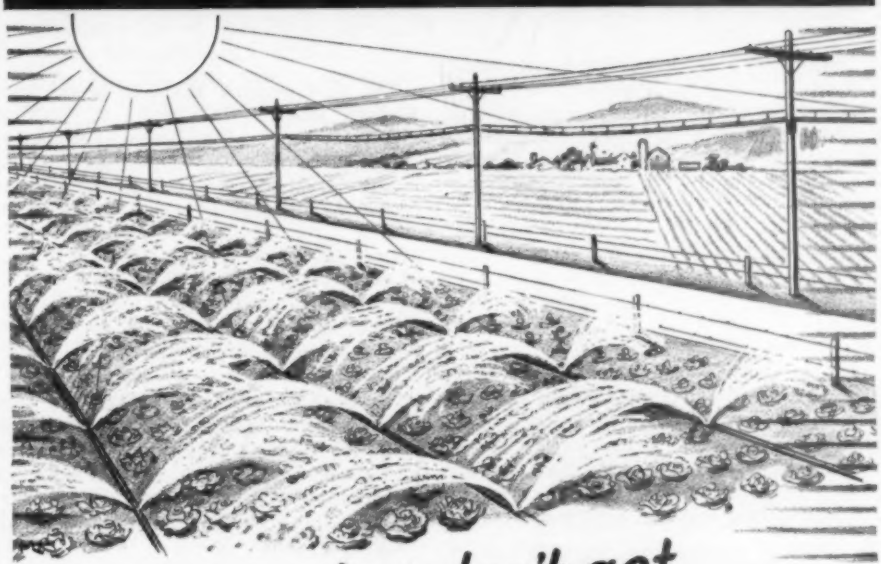


Perma-Code pipe identification system in actual use.

Perma-Code markers are mounted on Blue Streak dispenser cards for fast application. A special release coating allows distortion-free removal and use. A free Pipe Marker Planning Kit is available to help establish a standardized pipe identification system for the entire plant. It includes a planning guide, cost comparison charts, safety information, application photos, test samples, and a stock list.

Readers' Service Item P-5

"Colloid Corner" by COLUMBIAN



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New Literature

Write item numbers on Readers' Service card to obtain copies.

"Propionaldehyde." F-40110. Carbide & Carbon Chemicals Co. 13 pages. Physical properties, specifications, shipping data, and applications are listed for this chemical, an intermediate in the manufacture of polyesters and other resinous compounds. Typical reactions are reported, together with a bibliography.

Readers' Service Item L-1

"Sturtevant Dry Processing Equipment." Sturtevant Mill Co. 8 pages. The firm's blenders, mixers, crushing and milling machines, air separators, micronizers, granulators, elevators, and vibrating screens are described and illustrated in this bulletin.

Readers' Service Item L-2

"Plastics Rod and Tube Catalog." Friedrich & Dimmock, Inc. 24 pages. This publication lists sizes and prices for the firm's methyl methacrylate, Teflon, cast acrylic, vinyl, polyethylene, cellulose acetate, and polystyrene rod and tube stock.

Readers' Service Item L-3

"Super Dylan Polyethylene." Bulletin C-6-216. Koppers Co., Inc. 16 pages. This illustrated bulletin contains information on physical properties, processing, and fabrication of the low-pressure material. Injection molding, extrusion, and its application to bottles and blown articles are stressed.

Readers' Service Item L-4

"Injection Molding of Cycolac." Technical Report No. CY-3. Marbon Chemical, division of Borg-Warner Corp. 8 pages. Following a review of this copolymer's properties are descriptions of mold and gating construction, molding conditions, ram operations, purging, and a description of the properties to be expected from a molded part.

Readers' Service Item L-5

"Forming of Plio-Tuf Sheet." Processing 56-137. Goodyear Tire & Rubber Co. 8 pages. Vacuum draw forming, vacuum snap-back forming, drape forming, plug and ring forming, blow molding, and line bending are explained and depicted schematically. Mold design, materials, and their construction are covered, and the finishing operation is outlined.

Readers' Service Item L-6

"B. F. Goodrich Rigid Koroseal Pipe, Fittings, and Valves." 10050. B. F. Goodrich Co. 8 pages. Installation is explained, and applications and physical properties are reviewed. Chemicals handled successfully by Koroseal piping are listed.

Readers' Service Item L-7

"Dies and Machines for Cutting, Perforating, Flash Trimming, and Electronic Sealing." Western Supplies Co. 8 pages. This profusely-illustrated bulletin describes the company's line of gasket and washer dies, flashing trim dies, and clicker, hand-mallet, and dinker dies.

Readers' Service Item L-8

"Fundamental Mechanisms in Polyethylene Extrusion." Extruderitems No. 6. Bakelite Co. 20 pages. This is an article by B. H. Maddock of the Bound Brook laboratories, and contains numerous equations and graphs depicting the effects of various operating conditions on extruder output.

Readers' Service Item L-9

"Heat and Light Stabilizers of PVC." Ferro Chemical Corp. 4 pages. Stabilizer performance ratings in calendered, extruded, and molded compounds, plastisols, and organosols are given in this bulletin. Ratings are in terms of initial color, long term heat, clarity, light stability, resistance to sulfur stain, and heat stability with phosphate plasticizers.

Readers' Service Item L-10

"Georgia Kaolin Handbook." Georgia Kaolin Co. 74 pages. This notebook, a reference file for Georgia Kaolin bulletins, contains four as a starter, covering A Visit to Georgia Kaolin Co.; Progress through Georgia Kaolin Research; Ajax Kaolins; and Hydrite Kaolins in Reinforced Plastics.

Readers' Service Item L-11

"Naugatuck Plastics — Resin Guide." Naugatuck Chemical division, U. S. Rubber Co. 8 pages. This illustrated catalog gives the latest information on Kralastic resin-rubber copolymers, Vibrin polyesters, and Marvinol PVC's.

Readers' Service Item L-12

"Secrets of Commercial Polystyrene Production." Koppers Co., Inc. 3 pages. This bulletin provides background information on the development of styrene, and outlines some of the problems encountered in the production of today's commercial polystyrene.

Readers' Service Item L-13

"Can Do!" Peerless Roll Leaf Co. 4 pages. This brochure describes the company's services, including machinery design, attachments, stamping service, and pigments.

Readers' Service Item L-14

"Styrofoam Insulation Construction Details. AIA File No. 37B." Dow Chemical Co. 17 pages. Properties and specifications are quoted for the expanded polystyrene material, and 12 blueprints are included showing its installation in home insulation.

Readers' Service Item L-15

"Scotchpak." Minnesota Mining & Mfg. Co. 6 pages. This fold-out brochure describes and illustrates the various applications for Scotchpak brand heat-sealable polyester film. Physical and chemical properties are listed in tabular form.

Readers' Service Item L-16

"Poly-Eth Hi-D." Spencer Chemical Co. 5 pages. Property data and application photos are given for this material, which is

reported to have the highest density of any high-pressure polyethylene on the market.

Readers' Service Item L-17

"Stokes Industrial Compacting Presses." Catalog No. 816. F. J. Stokes Corp. 24 pages. This profusely-illustrated catalog gives specifications for the firm's compacting presses from the simplest to the most complicated.

Readers' Service Item L-18

"New Primers for Vinyl Dispersion Finishes." Release No. 21. Bakelite Co. 8 pages. These primers, based on a vinyl and a phenolic resin, are said to improve the adhesion of PVC coatings to metal surfaces. Formulations, pigmentation, exposure tests, and chemical resistances are described.

Readers' Service Item L-19

"Marlex 50 Polyethylene." Phillips Chemical Co. 28 pages. Technical data and application information are given in this four-color booklet. Test results are depicted in graphic form.

Readers' Service Item L-20

"Hy-Gear Application Chart." Ideal Corp. 1 page. This chart lists the correct stainless-steel clamp size for any given size and type of plastic pipe.

Readers' Service Item L-21

"Quelcor Systems for Corrosion Prevention." Bulletin 83. Quelcor, Inc. 4 pages. This revised booklet describes a new system being offered to industrial plants for the coating of parts and assemblies with PVC plastisols. Sample layouts give the step-by-step procedure, together with estimated costs.

Readers' Service Item L-22

"Low-Cost, High-Pigment-Volume Interior Paints Based on Bakelite Vinyl Acetate Resin Latex WC-130." Release No. 23. Bakelite Co. 8 pages. Formulations, general considerations, manufacturing procedures, theoretical yields, properties, and chemical resistances are given in this bulletin.

Readers' Service Item L-23

"Hopper-Dryer and New Combination Automatic Jet Hopper Loader for All Injection and Extrusion Machines." Thoreson-McCosh, Inc. 4 pages. Specifications and photographs of the units are contained in this bulletin, together with a schematic drawing of their mode of operation.

Readers' Service Item L-24

"The New 'Standard' in Automatic Molding." Bulletin No. A-456. Hull-Standard Corp. 4 pages. This bulletin describes the company's line of automatic compression presses available in sizes of 50, 75, 100, 150, 200, and 300 tons. Specifications for Model 450-B, a 75-ton press, are included.

Readers' Service Item L-25

"You Get the Best Way to Decorate It Today." Finish Engineering Co., Inc. 32 pages. Profusely illustrated, this catalog also serves as a guide for the selection of best spray gun action, type of mask, and other equipment for finishing a given part. Specifications and prices are given for all of the firm's equipment.

Readers' Service Item L-26

"Preparation of Molds." Marblette Corp. 2 pages. This leaflet explains the compositions and uses of the firm's mold preparation materials. These include a pasty wax-type, pre-size compound; a film-forming lacquer solution; a wax-coat; and a mold-release solution.

Readers' Service Item L-27

"Installation Guide for Plastic-Coated Raceways." No. 18-166. General Electric Co.'s conduit products department. 16 pages. This booklet contains step-by-step, illustrated installation details on the firm's plastic-coated, rigid steel conduit and electrical metallic tubing.

Readers' Service Item L-28

"Chlorowax LV—A Secondary Plasticizer for Vinyl Resins." Diamond Alkali Co., chlorinated products division. 5 pages. Properties of this liquid chlorinated paraffin are given, together with four typical vinyl formulations wherein the material is used as a secondary plasticizer. A 24-hour plasticizer exudation test for vinyl stocks also is outlined.

Readers' Service Item L-29

"Series 10 & 11 Bantam Speed Reducers." Bulletin No. 98. Metron Instrument Co. 8 pages. Specifications and dimensions are given for these small-size speed reducers which are used in radar, chart drives, flow controls, mixers, instrument test equipment, process controls, recorders, motor drives, timers, indicators, and regulators.

Readers' Service Item L-30

"Unplasticized PVC Pipe Fittings and Flanges." Albert Pipe Supply Co., Inc. 13 pages. This catalog not only lists the sizes and types available, but also gives considerable background material on the history, fabrication, and applications of rigid PVC pipe and fittings.

Readers' Service Item L-31

"Poly-Flex 100, A Cold-Setting Flexible Molding Compound." Technical Bulletin No. 12. Smooth-On Mfg. Co. 2 pages. Methods by which cold-set, synthetic-rubber molds can be made to duplicate plaster and epoxy models are described in this bulletin. Properties and methods of preparing the material for casting also are listed.

Readers' Service Item L-32

"Teflon, Zytel, Alathon, and Lucite." E. I. du Pont de Nemours & Co., Inc. 18 pages. This booklet contains application data, product description, and information on the forming and working of these four plastic engineering materials. An extensive physical property chart is included.

Readers' Service Item L-33

"Typical Physical and Electrical Properties of Epocast Electrical Insulating Materials." Furane Plastics, Inc. 3 pages. This fold-out chart lists physical and electrical data on the firm's 27 epoxy resin systems. Included herein are room temperature-set, heat-cured, filled, unfilled, resilient, and rigid Epocast resins.

Readers' Service Item L-34

Book Reviews

"The Condensed Chemical Dictionary." Fifth Edition. Arthur Rose and Elizabeth Rose. Reinhold Publishing Corp., 430 Park Ave., New York 22, N. Y. Cloth, 6½ by 9 inches, 1220 pages. Price, $12.50.

This greatly-enlarged edition contains over 30,000 revised and up-to-date entries on chemicals and allied substances. Employing simple, direct language, it is equally of use to the chemist and the non-chemist. Wide trade-name coverage is continued and expanded.

Typical of the information offered on a chemical are synonyms, grades, description, trade names, formulas, uses, derivations, chemical and physical properties, containers, hazards, and shipping regulations. The book should be a vital source of information for anyone engaged in the chemical or process industries.

"Chemical Process Industries." Second Edition. R. Norris Shreve. McGraw-Hill Book Co., Inc., 330 West 42nd St., New York 36, N. Y. Cloth, 6½ x 9¼ inches, 1020 pages. Price, $11.50.

This work takes a chemical engineering approach to the methods used in the manufacture of chemicals and chemical products. The text is broken down into unit processes, and operations are covered through the use of conventional flow sheets. Data on chemical and physical changes and reactions, economic statistics and costs, energy and power required, and quantities of materials required to produce the final product are given.

The first two chapters cover unit processes and operations, plus such general fundamentals as materials of construction, instrumentation, controls, containers, safety and fire protection, patents, research, and waste disposal. Later chapters are devoted to the following chemicals and chemical industries: fuels, coal chemicals, fuel gases, carbon, ceramics, glass, electrothermals, nitrogen, paint and varnish, essential oils, fats and waxes, soaps and detergents, sugar and starch, fermentation, pulp and paper, synthetic fibers, plastics, natural and synthetic rubbers, petroleum, intermediates, and many others. Name and subject indexes are included.

"Basic Chemistry of Textile Preparation." S. R. Cockett and K. A. Hilton. Philosophical Library, 15 East 40th St., New York 16, N. Y. Cloth, 5¾ by 9 inches, 204 pages. Price, $6.00.

This work is intended to provide a complete theoretical course in basic textile chemistry for students and workers in the field. Topics are considered in the following order: fiber structure and methods for determining same; chemistry of natural fibers; chemistry of plastics; chemistry of synthetic polymer and other man-made fibers; the properties of fibers; scientific methods of wetting and detergency; bleaching and color; related fields; and tests and defects.

The plastics chapter explains the general principles of the various types of polymerization, plus the particular features which must be present for the formation of a satisfactory textile fiber. Literature references, journals, patents, and information services are cited at the back of the book.

"Basic Chemistry of Textile Colouring and Finishing." S. R. Cockett and K. A. Hilton. Philosophical Library, 15 East 40th St., New York 16, N. Y. Cloth, 5¾ by 9 inches, 198 pages. Price, $6.00.

Various types of dyes and other coloring materials are considered along with the conditions under which each is applied, and the related subject of stripping. Dyeing machinery for fibers, yarns, fabrics, and garments is described and illustrated. This chapter also covers instrumentation and control methods.

The theory of dyeing, transfer of dye to fabric, thermodynamic and kinetic aspects of dyeing, and special dyes for synthetic materials are the next topics taken under consideration. The closing chapter is divided according to the processes required by the fibers' properties and the finish used. The book concludes with data on the coloring of plastics, food, and inks, plus tables on the identification of dyes and stains.

"The Development of Markets for New Materials." E. Raymond Corey. Harvard Business School, Soldiers Field, Boston 63, Mass. Cloth, 5½ by 8½ inches, 277 pages. Price, $4.00.

The book is primarily concerned with the development of new end-product markets for three relatively-new, fabricated materials; plastics, fibrous glass, and aluminum. Its purpose also is threefold: to describe in some detail the companies' efforts to build material markets through the development of new end products; to identify the characteristic marketing problems which were encountered; and to study their approaches to these problems.

Source material is a series of case studies, each describing the efforts of a materials producer to build a market for a new end-product. Three specific cases were fibrous glass-reinforced polyester pipe, polystyrene housewares, and vinyl tile. In each case the materials producer had to bring together a fabricator-customer group to lend its support to the idea.

Another section of the book describes the creation of an initial demand for new products, both industrial and consumer. Problems encountered in the development of a growing market are described, and related to later stages of market growth. They consist primarily of maintaining the general level of end-product quality, creating selective demand through brand promotion, and competing with customers.

"Weathering of Glass-Fabric-Base Plastic Laminates." F. Werren and B. G. Heebink. Forest Products Laboratory, Department of Agriculture for Wright Air Development Center. Order PB 121390 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper 56 pages. Price, $1.50.

Eleven glass-fabric-base plastic laminates, made with nine different laminating resins were subjected to outdoor weathering in five different climes for periods of three to twelve months. The full program covered three years. The laminates showed no severe strength reductions after a one-year exposure; however, most materials lost about 5-10% and heat-resistant polyester laminates lost over 20%. A final report covering all data on these tests will be published at a later date.

"The resistance of Glass Reinforced Plastics to Temperature-Humidity Cycling." F. R. Barnet, Naval Ordnance Laboratory. Order PB 121173 from OTS, U. S. Department of Commerce, Washington 25, D. C. Paper, 11 pages. Price, 50¢.

The Jan series of cycle tests were run on 24 different laminates with a view of selecting better ordnance materials for severe temperature-humidity cycling conditions. Laminates of heat-resistant resins and specially-finished glass fibers showed little or no decrease in flexural strength over a 28-day period. Some standard materials, however, lost over 50% of their strength. The Jan cycle test is recommended as a realistic method of determining the strength retention of laminated plastics under severe environmental conditions.

Abstracts of Important Articles

Materials

"Polymerization," A. F. Roche, *Ind. Eng. Chem.*, 48, 9, 1643 (Sept. 1956).

A review, with an extensive bibliography, of developments in the field of polymerization during the past year.

"Polysulfide-Epoxy Compositions," E. H. Sorg and C. A. McBurney, *Modern Plastics*, 34, 2, 187 (Oct. 1956).

Compositions, properties, and applications of polysulfide-epoxy compositions are described, with emphasis on their use in coatings and adhesives.

"Measuring the Effect of Plasticized Vinyls on Impact Polystyrene," R. R. Dixon, *SPE J.*, 12, 10, 17 (Oct. 1956).

A test is described and test data are given on measuring the flexural strength of polystyrene after it has been stressed and exposed to the vinyl compound.

"Polyurethane Foams," C. J. Harrington, *SPE J.*, 12, 10, 19 (Oct. 1956).

The properties, both physical and chemical, of the foams are discussed in detail. Extensive data are given on thermal conductivity; tensile, compressive, and bond strengths; solvent resistance; and oxygen-bomb aging.

"Accelerating Effect of Amines on Polymerization of Methyl Methacrylate," G. M. Brauer, R. M. Davenport, and W. C. Hansen, *Modern Plastics*, 34, 3, 153 (Nov. 1956).

A modified ultra-sonic viscometer was used to follow the polymerization of methyl methacrylate at 37° C. in the presence of benzoyl peroxide-amine catalyst. Polymerization with n,n-dimethyl-p-toluidine or 2, 2'-(m-tolylimino)diethanol gave products having the best physical properties.

"Chemical Constitution and Properties of High Polymers," G. Smets, *Ind. Plastiques Mod.*, 8, 2, 31; 8, 3, 29 (Feb. and March 1956).

The recurrence of structural elements and their orientation are basic in determining the physical properties of high polymers. How this works out is discussed in the case of polyethylene, vinyl polymers, and polyisoprene. The effect of branching is discussed, particularly in the case of polyamides and polyesters. Finally, copolymerization and its possibilities, especially those of graft copolymerization, are examined. (In French.)

"Properties and Application Techniques of Benzylcellulose," G. Just, *Plaste u. Kautschuk*, 2, 12, 217 (Dec. 1955).

Benzylcellulose, produced up to 1945 as Trolit BC in Germany, has been neglected since then. Preparation, processing, and application of the material were re-investigated in the light of the latest advances in cellulose chemistry and new methods were developed. All this is discussed, and new possibilities are mentioned. (In German.)

"Asbestos Reinforcements for Plastics Laminates," D. V. Rosato, *SPE J.*, 12, 8, 24 (Aug. 1956).

A discussion of asbestos fibers, papers, and felts, and their use as reinforcements for plastics to produce high modulus of elasticity, high tensile yield strength, retention of strength at high temperatures, insulating and thermal properties, and acid and flame resistance.

"Stronger Reinforced Plastics," J. W. Case, *Materials & Methods*, 44, 3, 114 (Sept. 1956).

Use of non-woven parallel glass mat, finished and bonded with an epoxy-type solvent solution, can double flexural strength and triple the elastic limit of reinforced polyester laminates.

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Request for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in March.

"Flow Behavior of Phenolics under Molding Conditions," D. I. Marshall, *SPE J.*, 12, 9, 25 (Sept. 1956).

The flow properties of phenolic molding compounds may be described as plastic flow with shear-rate thinning. This can be complicated by thixotropy and surface slip. The flow curve and hardening characteristics must be known in detail to understand the behavior of a given molding powder. During molding, filling of a mold is controlled by the flow curve, and flow stops when the stress value and the yield value approach each other. Method of measuring these properties and their rate of change with thermal hardening are described. A theoretical relation between lowest closing force and the yield value is derived.

"Plastisol Viscosity-Temperature Characteristics," W. D. Todd, D. Esarove, and W. M. Smith, *Modern Plastics*, 34, 1, 159 (Sept. 1956).

A method is described for continuously measuring the apparent viscosity of a plastisol as the temperature changes. Curves of test results provide a means of analysis and assist in the proper selection of ingredients and operating conditions.

"Cellulose Propionate Molding Compounds," D. A. Jones, *SPE J.*, 12, 8, 36 (Aug. 1956).

A brief review of the compounds, their general properties, molding, and extrusion.

"Polyvinylchloride Plastisols," C. Deterre, *Ind. Plastiques Mod.*, 8, 4, 32 (April 1956).

After a discussion of the properties of PVC plastisols, especially their viscosity characteristics, formulation methods are mentioned, and the various applications and processes are described, including coating and impregnation, molding, dipping, and foaming. (In French.)

"The Phenoplastics," M. Suprin, *Ind. Plastiques Mod.*, 8, 4, 28 (April 1956).

The phenolics are among the oldest synthetic plastics, but unlike some of the other earlier materials, have maintained a modest position in the modern world of plastics. The properties and uses which have made this possible are reviewed.

"Polymerization Rate of Unsaturated Polyesters with Different Catalysts, and their Practical Significance," P. Maltha and L. Damen, *Kunststoffe*, 46, 7, 324 (July 1956).

The equation first proposed by Berndtsson and Turunen to express the relation between the rate of polymerization and the activity and concentration of catalysts was applied to the study of the polymerization of a polyester resin with five different catalysts; benzoyl peroxide, cyclohexanone

peroxide, methylethyl ketone peroxide, lauroyl peroxide, and 2,4-dichlorobenzoyl-peroxide. Activity values obtained seem to justify the conclusion that in this respect, at least, there are notable differences between some systems. The values for activity and concentration, however, showed considerable divergence from those reported by Berndtsson and Turunen for the same catalysts, except in the case of benzoyl peroxide, and there also was agreement in the concentration values for 2,4-dichlorobenzoylperoxide. It is suggested the divergences may be due to the difference in polyesters used, possibly also to variations in the catalysts. Hence, the fact that the values for benzoylperoxide were most in agreement may indicate that this catalyst is least susceptible to differences in resin types. Nevertheless, the authors stress the need for greater care in attempting to draw conclusions of practical value from the above observations. On the other hand, they suggest that activity values could be utilized to follow the change in reactivity of unpolymerized resins during storage. (In German.)

"Mechanical Properties and Chemical Constitution," B. Persoz, *Ind. Plastiques Mod.*, 8, 5, 48 and 8, 6, 44 (May and June 1956).

Certain properties of linear plastics in the rigid form are influenced by chemical structure; the factors involved being degree of polymerization, crystallinity, lateral linkages, symmetry, and flexibility of the macromolecule. The mechanism involved in the deformation and rupture of the polymers is dealt with in special detail. In discussing the different kinds of linkages, the author notes that the convalent bond is extremely strong, the breaking load of a hydrocarbon chain being about several tons per square millimeter. Theoretically, therefore, it should be possible for a plastic to exceed the strength of the best metals. The rubbery state and the modulus of an elastomer, which is proportional to the number of points of attachments per unit of volume, also are considered. (In French.)

"Causes and Significance of Birefringence Phenomena in Injection Molded Polystyrene Parts," S. Wintergeist and K. Heckel, *Kunststoffe*, 46, 8, 365 (Aug. 1956).

In a brief article, the authors show the common belief that birefringence phenomena in injected polystyrene parts result from internal frozen strains to be largely in error, and that these phenomena are essentially due to molecular orientation. The possibilities for improving quality opened up by this finding are touched on, and will be more fully discussed at a later date. (In German.)

"Quantitative Determination of Urea and Melamine in Mixtures of Urea/Melamine-Formaldehyde Condensation Products," G. Widmer, *Kunststoffe*, 46, 8, 359 (Aug. 1956).

Urea and melamine in hardened and non-hardened materials consisting of a mixture of urea- and melamine-formaldehyde, were determined by ammonolysis reactions. Treatment with excess benzylamine yielded urea in the form of dibenzyl urea. For melamine, ammonolysis with aqueous concentrated ammonia was performed under pressure. The melamine was recovered by precipitation with picric acid in the form of melamine picrate. Partial decomposition during the processes reduced accuracy to about 90% which, however, is held adequate for most technical purposes. The method requires no highly trained personnel or specialized laboratories. (In German.)

"The Infra-red Analysis of Polymers," G. Salomon, *Plastica*, 9, 7, 366 (July 1956).

The correlation between the structure of organic compounds and their ability to absorb infra-red light is explained and illustrated by means of polymer spectra. Other spectra help to demonstrate the practical importance of the new method. Discussion of this subject is to be continued in a series of articles. (In Dutch.)

Equipment

"Practice Experience with Twin-Screw Extruders and their Application to Design," K. Tanner, *Kunststoffe*, 46, 9, 429 (Sept. 1956).

Studies of the conditions in processing thermoplastics with twin-screw extruders led to the conclusion that "fish eyes" in plastic extrusions are due to individual hard grains which have not been thoroughly heated and swollen by plasticizer. Thus, they reach the melting zone as hard cores in a protective mass, and float in the melt. The masses have viscosity so much higher than that of the surrounding melt that friction is no longer adequate for break-down of these masses, and "fish eyes" result. It was found that this condition could be eliminated if viscosity was adjusted by reducing temperature in the melting zone with the aid of a specially-designed, patented "Temperature Reduction Spindle" which actually is an extension of one of the twin screws. This and other features, including buttress-thread feed screws, were embodied in a new multi-purpose machine for granulating PVC, and processing rigid or plasticized PVC and other plastics without the need for changing the worm or other machinery part. (In German.)

"Ultrasonic Inspection by Pulsed Transmission," R. E. Seaman, *Brit. Plastics*, 29, 7, 262 (July 1956).

A brief description of the three ultrasonic techniques for detecting flaws in plastics materials is followed by a description of the pulse technique and the apparatus developed at Explosions Research and Development Establishment, British Ministry of Supply. These techniques expected to permit the inspection of large and small moldings and tubes, adhesion between bonded surfaces, glass-reinforced materials and many other purposes. The apparatus is patented.

"Mold Design for Injection Molding Machines," H. Gastrow, *Kunststoffe*, 46, 8, 386 (August 1956).

Molds with hot runners.

"The Significance of Convergence-Divergence in Extruders and Mixers," M. S. Frenkel, *Brit. Plastics*, 29, 8, 312 (Aug. 1956).

It is shown that the basic construction developed from the "Principle of the Potential of Convergence-Divergence" (British Plastics, May 1956, p. 184) provides its main features of performance not on the basis of theory, but in the sense of a long chain of reasoning from first principles. In this connection, performance is discussed in relation to several kinds of separation effects, several kinds of intermixing, multiple driving force, and self-adjustment and control of compression.

"Machinery and Equipment for Plastics at the 34th International Fair at Milan," M. Sirtoli, *Materie Plastiche*, 22, 6, 497 (June 1956).

High-speed automatic injection molding machines, some for rigid PVC and some of large capacity, including one with capacity of 6 kgs. (about 13.2 lbs.), were among the plastics processing machines drawing most attention. The most important designs featured by 28 firms, mostly Italian, are reviewed and illustrated. (In Italian.)

"Horizontal Separating Machine for Vacuum Moldings," Q. Hillesheimer, *Kunststoffe*, 46, 8, 389 (Aug. 1956).

A problem in vacuum forming is quick and clean separation of molded parts. A horizontal separating machine has been developed which eliminates the usual wasteful process of separating individual parts. The main features of the new device, which also can be used for articles of complicated shapes and thicknesses from 0.2-3 mm., are table control and cutter band compensation. (In German.)

"Pendulum Elastometer for Very Small Samples," P. Le Rolland and P. Sorin, *Ind. Plastiques Mod.*, 8, 4, 34 (April 1956).

In discussing the concept of "Modulus of Elasticity," the authors claim that only a method utilizing forced vibrations, like their pendulum method, by which the influence of flow reactivity, and internal friction are eliminated, is applicable to the study of the elasticity of plastics. The pendulum method is based on the relation which calculations have shown to exist be-

tween the period of the "beat" of double pendulums (the apparent regular alternation of vibration between the two pendulums) and the elastic modulus of a sample of given dimensions. Appropriate equations are developed, and application of the method is illustrated in a new elastometer using small samples. (In French.)

"Problems and Trends in European Extruder Design," E. Gaspar, *SPE J.*, 12, 10, 23 (Oct. 1956).

A review of the investigation conducted by Projectile & Engineering Co., of England, to gather basic data used in design of the firm's single-screw extruders.

"Viscosity Data for Extruder Flow Equations," R. D. Sackett, *SPE J.*, 12, 10, 32 (Oct. 1956).

Approximate value of apparent extrusion viscosity are given for use in extruder flow equations.

"Basic Factors to be Considered in Developing Cost of Molds," J. A. Kavanagh, *SPE J.*, 12, 10, 37 (Oct. 1956).

A discussion of some factors involved in mold costs, from the viewpoint of a moldmaker. These factors include tolerances, taper or draft, and mold try-out tests.

"An Autographic Apparatus for the Study of Thermal Distortion," M. T. Watson, G. M. Armstrong, and W. D. Kennedy, *Modern Plastics*, 34, 3, 169 (Nov. 1956).

An apparatus is described for plotting autographically the thermal distortion behavior of molded plastics, extruded and cast films, and yarns. Typical test results provide information on effect of molding conditions, plasticizer content, and degree of crystallization of the material.

"Preplasticators Pay Off on Small Shots, Too," H. H. Schwartz, *Modern Plastics*, 34, 3, 143 (Nov. 1956).

Preplasticators provide advantages (uniform melt temperature, better control of injection pressure, and greater productivity of parts) which make them desirable for molding of small shots.

Processing

"On the Stabilization of PVC-Based Compounds," F. Chevassus, *Ind. Plastiques Mod.*, 8, 2, 23 (Feb. 1956).

The main purpose of this article is to call attention of French processors of PVC to the many stabilization problems that arise in practice and, at the same time, to indicate the large number of stabilizers commercially available, especially in America. It is attempted to point out the dangers of using these stabilizers without a perfect knowledge of basic factors. (In French.)

"Cementing Styrene Surfaces," R. E. Hammer, *Western Plastics*, 3, 10, 17 (Oct. 1956).

A discussion of cements and cementing equipment for fabrication bonding of styrene.

Applications

"Adhesive-Bonded Metal Parts in Aircraft Construction," R. J. Schliekelmann, *Plastica*, 9, 7, 374 (July 1956).

In the construction of the Fokker F-27 plane, riveting of metal parts has been replaced by the Redux adhesion process in which union is achieved by polar attraction between the molecules of the contact surface and the adhesive. Details are given of the fabrication method which includes the coating of aluminum alloy parts (pretreated with chromic and sulfuric acids to give the metal surface the needed polar properties) with a phenol-formaldehyde based liquid, over which is spread a Formvar powder. Then, pressure is applied. Advantages of the method are explained. (In Dutch.)

"Plastics at the 34th International Fair at Milan," R. Pozzo, *Materie Plastiche*, 22, 6, 453 (June 1956).

With the rapid development of the plastics industry in Italy, the section devoted to plastics at the International Fairs in Milan has become more extensive each year. Brief, illustrated descriptions are given of items featured at the 1955 Fair in the displays of Italian firms and of Italian representatives of foreign concerns. These applications include paneling, roofing, and boats made of polyester resin. (In Italian.)

"Reinforced Plastics in the Construction of External Pressure Vessels," F. R. Barnet and C. L. Lloyd, *SPE J.*, 12, 8, 15 (Aug. 1956).

By selection of the proper glass reinforcements, wall thickness and effective length can be controlled and effective designs produced. As such, glass-reinforced plastics are very suitable materials of construction for specialized external pressure vessels.

"Synthetic Resins in Combating Corrosion," J. Carabosse, *Plastiques Informations*, 1 (June 1, 1956).

Reference is had mainly to polyesters, their properties and behaviour in the presence of acids, alkalis and other reactive substances. Among the suggested applications for polyesters are containers for corrosive liquids and compressed air; floor coverings; coatings for articles in contact with sea water; various ship-board uses; storing and transporting saline solutions of organic products; and, in general, wherever the air is polluted by gases, acids, or saline liquids. (In French.)

"Thin-Wall Epoxy-Glass Tubing," W. E. Ponemon, *Modern Plastics*, 34, 3, 139 (Nov. 1956).

A description of the properties of small-diameter, thin-wall tubing made from epoxy resin reinforced with woven glass sleeving.

"How to Get Good Parts in Reinforced Plastics," Maurice Martin, *Materials & Methods*, 44, 4, 118 (Oct. 1956).

Quality of reinforced plastic parts is shown to depend on good design and quality control.

General

"Importance of Engineering Talent in the Operation of a Plastic Custom Molding Company," H. S. Ruekberg, *SPE J.*, 12, 9, 43 (Sept. 1956).

A review of engineering operations by the molder in product design, molding technique, mold design, and machine maintenance.

"New Fields for Plastics," J. O. Reinecke, *SPE J.*, 12, 9, 34 (Sept. 1956).

A generalized prediction of future areas of application for plastics.

"Plastics," R. B. Seymour, *Ind. Eng. Chem.*, 48, 8, 1760 (Sept. 1956).

A comprehensive review and bibliography of developments in plastics as materials of construction during the past year.

"An Effective Project Engineer System," H. T. Douglas, *Plastics World*, 14, 10, 4 (Oct. 1956).

Description of a work system used by Lunn Laminates in manufacturing molded reinforced plastic parts.

"Safety Procedures in the Reinforced Plastics Plant," J. R. McCullough, *SPE J.*, 12, 10, 39 (Oct. 1956).

A brief discussion of safety procedures in the plastics division of The Budd Co.

Patent Digest

Materials

Plasticizing Polyamides with N-Alkyl Alkanesulfonamides. No. 2,757,156. Joachim Dazzi, Dayton, O. (to Monsanto Chemical Co., St. Louis, Mo.).

This synthetic, linear, high molecular weight, polymeric carbonamide is plasticized with a mixture of n-ethyl n-heptanesulfonamides.

Esters of Pentanediols and Their Use as Plasticizers for Vinyl-Type Polymers. No. 2,757,157. Stanford J. Hetzel, Cheltenham, Pa. (to Sun Oil Co., Philadelphia, Pa.).

The polyvinyl chloride composition is plasticized with 1,5-pentanediol dibenzoate.

Polyester Resin Compositions. No. 2,757,158. Joseph R. Darby and August R. Hempel, Webster Groves, Mo. (to Monsanto Chemical Co., St. Louis, Mo.).

The process comprises mixing 100 parts by weight of an unsaturated polyester resin, 10-100 parts by weight of a vinyl aromatic compound copolymerizable with the polyester, and 15-50 parts by weight of a benzyl phthalate.

Acid Resisting Silicane Cements Containing Thermoplastic Resin. No. 2,757,168. Francis Robert Himsworth and Harry Hughes, Norton-on-Tees, England (to Imperial Chemical Industries, Ltd., Great Britain).

Acid-resistant cements are rendered alkali-resistant by adding an alkali metal silicate binder and a substance which accelerates the setting of said cement. Polyethylene or a polymerized halogen-substituted hydrocarbon is incorporated into the cement and heated to a temperature sufficient to melt the thermoplastic material.

Water-Repellent Compositions Comprising a Polysiloxane, a Urea- or Melamine-Formaldehyde Resin, and a Curing Agent. No. 2,757,152. Myer Michael Solomon, Albany, N. Y. (to General Electric Co., Schenectady, N. Y.).

The composition consists of an organopolysiloxane, an incompletely condensed aminoplast resin, and a metallic salt capable of effecting cure. It is substantially free of organopolysiloxanes containing hydrogen attached directly to silicon.

Process for Water-Soluble Styrene-Maleic Anhydride Derivatives. No. 2,757,153. Albert H. Bowen, Seattle, Wash. (to Monsanto Chemical Co., St. Louis, Mo.).

A styrene-maleic anhydride heteropolymer is suspended in a water-immiscible aromatic solvent, wherein the latter is a solvent for the monomers only. Water is added to bring the final content to 1-2.5 parts by weight of water per part by weight of heteropolymer.

Acrylonitrile-Vinyl Pyridine Copolymer Solutions. No. 2,757,154. Ralph Gardner Beaman, Buffalo, N. Y. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The composition contains 85-95% by weight of acrylonitrile, and 5-15% of a vinyl pyridine dissolved in n-methyl-n-ethylacetamide, n,n-dimethyl-propionamide, and n-acetyl piperidine.

Stabilized Chlorosulfonated Hydrocarbon Polymer Compositions. No. 2,757,155. Ralph H. Sudekum, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

The liquid composition comprises a homogeneous mixture of an uncured halosulfonated polymer of ethylene in an inert organic liquid. The latter consists of solvents for the polymer, and non-solvents which are capable of swelling it. About 10-100 parts of a flocculated metal are added per 100 parts polymer.

Resinous Layers Having a Selected Degree of Water Sensitivity and Method of Making Same. No. 2,756,163. Clifford E. Herrick, Jr., Binghamton, N. Y., and William F. Amon, Jr., St. Paul, Minn. (to General Aniline & Film Corp., New York, N. Y.).

A compatible solvent solution consisting of hydrophobic, organic, film-forming material and a resinous copolymer of a vinyl compound and maleic acid is formed, which gives a substantially clear layer upon drying. This solution is coated upon a support, dried, and treated with a moist base alkali until the resulting layer swells in water.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Price, 25c each.

—The Editor

Alkylated Polystyrene Pour Depressants. No. 2,756,265. William C. Hollyday, Jr., Fanwood, N. J. (to Esso Research & Engineering Co., New York, N. Y.).

A polystyrene with an intrinsic viscosity of 0.2-1 is dissolved in a solvent. About 10-25% by weight of a Friedel-Crafts catalyst is added, and sufficient nitrobenzene so that the mol ratio of nitrobenzene to catalyst is within the range of 0.2-0.8. Finally, an aliphatic, olefinic hydrocarbon containing 16-20 carbon atoms per molecule is added, and the temperature is maintained at 80-150° F.

Plasticized Polyvinyl Chloride Polymer. No. 2,757,151. Joachim Dazzi, Dayton, O. (to Monsanto Chemical Co., St. Louis, Mo.).

The compound comprises a vinyl chloride polymer plasticized with an adduct of unsaturated, non-hydroxylated fatty oil and a dialkyl fumarate.

Polymerization of Ethylene with Bis-diazobenzenesuccinate. No. 2,758,107. Randall G. Heiligmann and Palmer B. Stickney, Columbus, O. (to Borden Co., New York, N. Y.).

Ethylene is maintained at a pressure of at least 1,000 psi., and at a temperature of 35-250° C., in the presence of bis-benzenesiazosuccinate.

Pyrolysis Process for Making Perfluoropropene from Tetrafluoroethylene. No. 2,758,138. David A. Nelson, Newark, Del. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

Monomeric tetrafluoroethylene is continuously fed into a reaction zone which is heated to a pyrolysis temperature of 750-900° C. Rate of addition is 20-5,000 grams per hour. Upon cooling, a 75% yield of hexafluoropropene is obtained.

Production and Recovery of Trichloroethylene. No. 2,758,139. Charles A. Bordner, Niagara Falls, N. Y. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

A crude mixture of chlorinated hydrocarbons is steam-distilled with a lime slurry at a pH of 11-12. The distillate is condensed, and the trichloroethylene is recovered. Part of the residue containing calcium chloride is added to a fresh lime slurry and reacted with a fresh batch of crude trichloroethylene.

Water-Soluble Phenol-Formaldehyde Resins. No. 2,758,101. Harold M. Shappell, Bound Brook, N. J. (to Union Carbide & Carbon Corp., New York, N. Y.).

A highly water-soluble condensate characterized by a high yield of phenol-formaldehyde solids is obtained by reacting a mol of phenol and at least 2.5 mols of formaldehyde at a pH of 8.4-11.5 in the presence of a non-volatile, inorganic, alkaline catalyst. A reaction temperature of 80° C., is

maintained until a condensation product with a water miscibility of at least 500% is obtained. The condensate is partially neutralized by the addition of a water-soluble acid, bringing the final pH to about 7.3-7.8.

Polyvinyl Chloride Dissolved in Mixtures of a Cyclic Ether and an Amide. No. 2,758,104. Robert L. Adelman, Grand Island, N. Y. (to E. I. du Pont de Nemours & Co., Inc., Wilmington, Del.).

A high-molecular weight homopolymer of vinyl chloride is mixed with 0.6-19 parts by volume of tetrahydrofuran and one part by volume of a dialkyl formamide.

Improvements in the Production of Polymerization Products Using Redox Catalysts. No. 2,758,106. Hellmut Bredereck and Erich Bader, Stuttgart, and Adolf Wohnhaas, Grunbach/Remstal, Germany (to W. C. Heraeus G.m.b.H., Hanau, Germany, and Deutsche Gold- und Silber-Scheideanstalt vormals Roessler, Frankfurt am Main, Germany).

Monomeric methyl methacrylate is mass-polymerized in the presence of polymethyl methacrylate and a two-phase catalyst. The latter consists of a tertiary- or secondary-sulfone amine and a mixture or air and peroxides in the presence of a non-polymerizable monohydroxy alcohol.

Olefin Polymerization Process. No. 2,758,143. Erving Arundale and Byron M. Vanderbilt, Westfield, N. J. (to Esso Research & Engineering Co., New York, N. Y.).

The olefins are contacted with a mixture of an inorganic acid of phosphorus and a hydrocarbon ester of phosphoric acid containing at least one aromatic hydrocarbon substituent group. Polymerization conditions are maintained.

Equipment

Knock-Out Device for Molding Machine. No. 2,757,414. Roger S. Chaloupka, Cleveland, O. (to Moslo Machinery Co., Cleveland, O.).

The work holder comprises a base, a work-holder slide mounted for back-and-forth movement, an ejector slideably mounted in the work holder, and a means for moving the ejector. A cam, fixed relative to the base, and a follower which is adapted to ride on the cam, move the ejector to sliding position.

Die for Cutting Threads on Non-Metallic Articles. No. 2,757,393. Francis L. Galloway, Cuyahoga Falls, O.

This annular die for threading plastic hose is chamfered at its free end and provided with internal threads adjacent to the edge of the chamfer. At least one flute extends from the free end of the die across the chamfer and threads. The thread ends are deflected sharply inwards, with the plane of the leading edge sufficiently foreward of the die center to give a cutting angle. The die wall trails cylindrically through an angle of at least 90 degrees, and constitutes a guide and support for the threads cut into the hose when rounded out.

Presses for Molding Plastic Substances. No. 2,756,480. William Herbert Smith, East Molesey, England.

The block molding press consists of a mold, a ram, a pivoted arm, a pivoted lever for engaging the arm, a unidirectional rotary shaft, and a cam mounted on the rotary shaft. The latter is adapted to engage the other end of the lever and raise it during partial rotation of the shaft. This causes the hook to be drawn downward to lower the ram into the mold.

Apparatus for Applying Plastic Coatings to Articles. No. 2,755,507. Robert M. Heller, Birmingham, Mich.

A support is adapted to engage over the top of a cup-shaped body, its lower molding surface extending outwardly. This support also has an elongated, downwardly-extending, forming member for closing the opening in the bottom of the body. Other parts include a container for liquid plastic material, a means for dipping support and body into said container, and a separating means.

Mold Apparatus for Tiles and Other Plate-like Structures. No. 2,755,508. Mario Maccaferri, Rye, N. Y.

The injection mold structure consists of a fixed mold section with core plate and pin for receiving bushings; a movable mold section clamped against the fixed section; body structure and mold-cavity block; core pins mounted on the body structure opposite the mold cavity; a means for moving the body structure and core pins; and a means for arresting their movement and effecting retraction.

Impact Testing Machine. No. 2,755,658. Paul V. Brown, Bellwood, Ill. (to Richardson Co., Melrose Park, Ill.).

Impact resistance is tested by means of a free-falling weight in a stationary frame. A second frame is vertically-adjustable on the stationary frame, and an electromagnetic assembly is supported by and is vertically-adjustable on the second frame. Other parts include an indexing element and a release element.

Pipe Testing Machine. No. 2,755,661. Hugo Lorant, New York, and Francis J. Kent, Forest Hills, N. Y. (to Baldwin-Lima-Hamilton Corp., Philadelphia, Pa.).

The machine has sealing heads for supporting the pipe and a test liquid-supplying passage of smaller cross-sectional area than the pipe. A nozzle device fits into the liquid-supplying passage, the other end extending a substantial distance into the pipe. This device is divided into cells to minimize the expansion effect on the liquid during its flow.

"Design of Molding Equipment for Injection Molding Machines," H. Gastrow, *Kunststoffe*, 46, 7, 346 (July 1956).

Ejection with the aid of compressed air. (In German.)

"Continuous Production of Molding Compositions by the Nozzle-Mixer Method," R. Hessen, *Plaste u. Kautschuk*, 3, 7, 146 (July 1956).

The nozzle-mixer designed by Nowack and Hessen is described, and its working method discussed. A lay-out is shown and explained in which the nozzle-mixer is connected with grinding, milling, and conveying equipment for continuous, fully automatic production of molding compositions. (In German.)

Plastics Mixing and Extrusion Machines. No. 2,753,595. Frederick E. Dulmage, Saginaw, Mich. (to Dow Chemical Co., Midland, Mich.).

The extruder consists of the following parts: feed end; discharge end; horizontally-disposed, cylindrical barrel; and a single, elongated rotor comprising two compressive-screw sections in tandem with a helically-grooved milling section. The barrel has a devolatilization port in the section surrounding the milling portion of the rotor and positioned near the discharge end.

Method and Apparatus for Making Plastic Tubing. No. 2,753,596. James Bailey, West Hartford, Conn. (to Plax Corp., West Hartford, Conn.).

The apparatus includes an extruder; a die with annular, concentrically-disposed die orifices; and a means for expanding and pressing the hot plastic tubes into bonding engagement with one another.

Processing

"The Manufacture of Bottles and Other Hollow Articles from Polyethylene," H. Spies, *Plastverarbeiter*, 7, 7, 250 (July 1956).

A Norwegian process (patent applied for) is described by which bottles can be made from pre-forms on ordinary four-column injection machines with the aid of certain additional attachments. No changes in the machine itself are required. The attachments cost only a fraction of the price of a special bottle-blowing machine. The process is fully automatic, and it is said that a variety of shapes can be produced cheaply. (In German.)

Method for Handling and Melting Nylon to Be Used in Molding Articles. No. 2,757,-416. Eugene E. Montross, West Wyomissing, Pa. (to Polymer Corp., Reading, Pa.).

A column of nylon is melted and continuously advanced into a mold without contact by air, then into a second mold, and finally applying pressure. This pressure is maintained while the molds are being cooled.

Process for Production of Puffed Fabrics. No. 2,757,434. Douglas D. McCord, New York, N. Y., and Thomas R. Holbrook and Charles A. Rudolph, Cornelia, Ga. (to Chicopee Mfg. Corp., Chicopee Falls, Mass.).

The main body of the fabric structure consists primarily of thermoplastic filaments, with heat-shrinkable thermoplastic filaments floated predominantly at the back of the main body and across areas in which puffs are to be formed. Heat is applied differentially to the shrinkable filaments, causing the back to shrink into the desired puffs.

Method of Forming Filamentous Panels. No. 2,756,174. Ralph G. H. Siu, Philadelphia, Pa.

Fibrous glass-reinforced resin panels are formed by forcing a filament-forming resin liquid through two nozzles into a spiraling blast of gas which is in constant movement in a vortex. The resultant, entangled mass of resin and glass filaments is compressed to fusion. A panel is formed with its surface regions more strongly fused than its interior.

Extrusion of Polytetrafluoroethylene. No. 2,752,637. Benjamin M. Walker, Caldwell, and Leland W. VanDenburgh, Jr., Packanack Lake, N. J. (to Resistoflex Corp., Belleville, N. J.).

Articles are extruded from a paste comprising finely-divided polytetrafluoroethylene and a volatile lubricant. About 0.01-5% by weight of carbon black is distributed throughout the mixture prior to extrusion.

CALENDAR of COMING EVENTS

January 30
Reinforced Plastic Group, SPE New York Section. Tufaro's Restaurant, Corona (Queens).

February 1
Detroit Rubber & Plastics Group. Winter Meeting.

February 4-8
ASTM Committee Week. Benjamin Franklin Hotel, Philadelphia, Pa.

February 5
SPE Kansas City Section. Milleman's Restaurant, Kansas City, Mo.

February 5-7
SPI Reinforced Plastics Division. Twelfth Annual Conference. Edgewater Beach Hotel, Chicago, Ill.

February 6
SPE Western New England Section. Bradley Field, Windsor Locks, Conn.

February 7
SPE Southern California Section. Scully's Restaurant, Los Angeles, Calif.

February 8
SPE Connecticut Section. Hotel Barnum, Bridgeport, Conn.

SPE Northern Indiana Section. Chamber of Commerce Building, Fort Wayne, Ind.

February 11
SPE Cleveland-Akron Section. Spanish Tavern, Brecksville, O.

February 12
SPE Baltimore-Washington Section. Friendship International Airport, Baltimore, Md.

SPE Milwaukee Section. Bavarian Club, Milwaukee, Wis.

February 13
SPE Newark Section. Military Park Hotel, Newark, N. J.

February 15
SPE Buffalo Section. Park Lane Restaurant, Buffalo, N. Y.

February 18
SPE Southern Section. Mammy's Shanty, Atlanta, Ga.

SPE Upper Midwest Section. Worwe's Cafe, Minneapolis, Minn.

February 19
SPE Ontario Section. Town & Country Club, Toronto, Ont.

SPE St. Louis Section. Melbourne Hotel, St. Louis, Mo.

February 20
SPE New York Section. Governor Clinton Hotel, New York, N. Y.

February 21
SPE Eastern New England Section. Hotel Beaconsfield, Boston, Mass.

SPE Pittsburgh Section. Cappy's Restaurant, Pittsburgh, Pa.

February 26
SPE Central Indiana Section. Warren Hotel, Indianapolis, Ind.

SPE Philadelphia Section. Franklin Institute, Philadelphia, Pa.

February 27
SPE Quebec Section. Queen's Hotel, Montreal, Que.

February 27-March 1
ASTM Committee D-20 on Plastics. Roanoke Hotel, Roanoke, Va.

March 18-21
Pacific Coast Plastics Exposition. Shrine Exposition Hall, Los Angeles, Calif.

SPI Annual National Conference. Hotel Biltmore, Los Angeles, Calif.

April 3
SPE New York Section. Regional Technical Conference. Plastics for Building. Hotel Statler, New York City.

April 4-5
SPI of Canada. Annual Conference. Ottawa, Ont.

Applications

Safety Window Construction. No. 2,755,-518. Charles F. Stroud, Tarentum, Pa. (to Pittsburgh Plate Glass Co., Allegheny County, Pa.).

The transparent closure comprises a pair of transparent sheets bonded to an interlayer of transparent thermoplastic material. A reinforcing member extends beyond the peripheral edge of the thermoplastic material, and a pair of resilient, moisture-resistant framing members surround the periphery of the laminated structure. Thin strips of polyvinyl butyral are attached on opposite peripheries of the framing members to form a bond between the transparent sheets and the inner peripheries of the frames, and to form a protective covering for the outer peripheries of the frames.

Safety Glass Laminate Containing Transparent Filler for Silicone Resins. No. 2,-756,171. Frederick L. Thomas, Madison, Wis. (to Bjorksten Research Laboratories, Inc., Madison, Wis.).

The glass sheets have a laminated interlayer of heat-resistant, transparent organopolysiloxane. The latter has a filler with a cubic crystal lattice structure, and which is isotropic to light in the visible spectrum. This filler is selected from the class of materials including fluorides of alkaline earth metals with atomic weights of less than 138.

Fused Fabric Assemblies. No. 2,757,435. Lajos Bihaly, London, England (to Trubenised Co., Vaduz, Lichtenstein).

A mixed fabric for use in the production of fused fabric assemblies, it consists of non-adhesive strands which are made up of fine filaments. These are laid-up with little or no twist and interwoven to constitute a fabric. Thermoplastic monofils are interwoven throughout the fabric, which is then heated to cause adhesion of the combined strands.

(*Continued on page 74*)

Domestic Production and Sales of Plastics and Resin Material, August and September, 1956

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of August and September, 1956. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

Little or no change is shown in September, and any fluctuation can be considered normal. More polyethylene continues to be produced each month and steady gains have been shown since its separate listing.

	August		September	
Cellulose Plastics:[1]	Production	Sales	Production	Sales
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,786,688	1,600,604	1,882,989	1,833,050
Sheets, 0.003 gage and over	1,513,899	1,486,429	1,502,804	1,449,587
All other sheets, rods, and tubes	514,580	537,029	559,279	544,252
Molding and extrusion materials	7,394,790	7,697,619	8,578,843	7,888,442
Nitrocellulose sheets, rods, and tubes	443,064	376,011	324,031	354,412
Other cellulose plastics	554,455	459,330	278,760	243,628
TOTAL	12,207,476	12,157,022	13,126,706	12,313,371
Phenolic and Other Tar-Acid Resins:				
Molding materials[1]	16,113,590	13,730,256	15,790,999	13,848,050
Bonding and adhesive resins for—				
Laminating (except plywood)	4,782,947	3,640,002	5,731,691	4,359,199
Coated and bonded abrasives	841,039	752,970	1,093,466	1,049,778
Friction materials (brake linings, clutch facings, and similar materials)[7]				
Thermal insulation (fiber glass, rock wool)	4,401,617	4,028,950	4,084,211	4,181,296
Plywood	3,746,527	3,143,486	3,880,554	2,838,631
All other bonding and adhesive uses	4,300,979	3,660,109	4,184,924	3,996,584
Protective-coating resins, unmodified and modified except by rosin	2,361,017	1,694,502	2,175,912	1,966,734
Resins for all other uses	3,639,087	3,142,444	2,904,106	2,782,738
TOTAL	40,186,803	33,792,719	39,845,863	35,023,010
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,653,805	2,711,390	2,293,566	2,647,683
Paper-treating and paper-coating resins	1,748,087	1,666,486	2,199,572	1,769,175
Bonding and adhesive resins for—				
Plywood	8,003,725	8,085,684	7,916,451	7,786,363
All other bonding and adhesive uses, including laminating	1,714,574	2,143,918	1,826,474	1,842,553
Protective-coating resins, straight and modified	2,816,943	2,365,834	2,951,392	2,372,678
Resins for all other uses, including molding	7,050,764	7,352,212	7,581,213	7,179,152
TOTAL	23,987,898	24,325,524	24,768,668	23,597,604
Styrene Resins:				
Molding materials[1]	34,519,055	31,072,856	37,283,849	30,704,246
Protective-coating resins, straight and modified	6,400,596	7,153,740	6,736,933	7,200,149
Resins for all other uses	9,768,958	9,701,051	12,030,312	7,498,913
TOTAL	50,688,609	47,927,647	56,051,094	45,403,308
Vinyl and Vinyl Chloride Resins:[3]				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		6,497,296		7,159,349
Sheeting (resin content)		4,788,967		4,194,099
Molding and extrusion (resin content)		17,489,758		17,227,794
Textile and paper treating and coating (resin content)[8]		5,727,452		5,197,682
Flooring (resin content)		6,797,597		5,525,601
Protective coatings (resin content)		2,415,731		2,025,157
All other uses (resin content)		7,227,733		5,945,170
All other vinyl resins for—				
Adhesives (resin content)		3,255,792		2,892,694
All other uses (resin content)		9,213,204		9,290,606
TOTAL	57,121,141	63,411,530	60,236,772	59,821,250
Coumarone-Indene and Petroleum Polymer Resins	22,755,324	22,466,719	20,512,939	20,537,902
Polyester Resins	6,633,774	5,355,020	5,368,906	4,601,731
Polyethylene Resins	49,790,470	46,400,186	51,089,205	40,056,029
Miscellaneous Synthetic Plastics and Resin Materials:				
Molding materials[1, 4]	3,258,996	3,381,000	3,468,300	3,795,576
Protective-coating resins[5]	1,033,078	480,817	1,054,665	568,490
Resins for all other uses[6]	9,881,302	9,382,856	9,829,632	8,488,874
TOTAL	14,173,376	13,244,673	14,352,597	12,852,940
GRAND TOTALS	277,544,871	269,081,040	285,352,750	254,207,145

[1]Includes fillers, plasticizers, and extenders.
[2]Production statistics by uses are not representative, as end use may not be known at time of manufacture.
[3]Includes data for spreader and calendering-type resins.
[4]Includes data for acrylic, nylon, silicone, and other molding materials.
[5]Includes data for epichlorohydrin, acrylic, silicone, and other protective-coating resins.
[6]Includes data for acrylic, rosin modifications, nylon, silicone, and other plastics and resins for miscellaneous uses.
[7]Included with "All other bonding and adhesive uses."
SOURCE: United States Tariff Commission, Chemical Division.

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INDEX TO ADVERTISERS

JANUARY, 1957

Allied Chemical & Dye Co. Semet-Solvay Petrochemical Division	15
Argus Chemical Corp.	6
Godfrey L. Cabot, Inc.	10
Carbide & Carbon Chemicals Co.	Fourth Cover
Columbian Carbon Company	63
J. E. Doyle (Statikil)	55
Eastman Chemical Products, Inc. Plastics Division	49
Erie Foundry Company	18
Escambia Chemical Corp.	12
General Tire & Rubber Company Chemical Division	14
The Glidden Company	5
B. F. Goodrich Chemical Company	Third Cover
Goodyear Tire & Rubber Company Chemical Division	1
W. R. Grace Co.	56
The Harshaw Chemical Co.	60
Improved Machinery, Inc.	8
Marbon Chemical A Division of Borg-Warner, Inc.	9
Merix Chemical Company	62
Metasap Chemical Co.	7
Monsanto Chemical Co.	17
Pasadena Hydraulics, Inc.	61
Shell Chemical Corporation	Second Cover
U. S. Industrial Chemical Co.	2
R. T. Vanderbilt Co., Inc.	57

Patent Digest *(Cont'd. from page 72)*

Plastic Window Frame. No. 2,753,605. Charles F. Strawther, Los Gatos, Calif.

The integrally-molded window frame of box sectional shape and rectangular configuration includes a plastic nailing flange co-planar with the interior face of the frame. A plastic drip-flange, integral with the lower run of the frame, extends exteriorly therefrom. The plastic sash seat with marginal flange extends interiorly from the inward face of the box section, substantially parallel to the nailing flange.

Gun Stock of Expanded Cellular Plastic Material. No. 2,753,642. George C. Sullivan, Hollywood, Calif.

Butt and forestock portions comprise an external skin portion and core; the latter consisting of cast, low-density, rigid, expanded cellular plastic. Skin and core are secured together by a natural adhering action to form a unitary structure.

Current Market Prices

This listing is as comprehensive and up-to-date as possible. The full listing will appear quarterly, while intervening issues will carry a briefer tabulation of price changes and additions.

Companies whose products do not appear are invited to submit price data for inclusion in the listing. All suppliers are requested to submit product additions and price changes promptly as they occur, in order to make this listing of maximum value to our readers.

Prices, in general, are f.o.b. works. Ranges indicate quantity or grade variations. No guarantee of these prices is made, and spot prices should be obtained from the individual suppliers.

— The Editor

Adhesives

Ampcoflex Adhesive	gl.	$2.75 / $3.50
Bakelite BC—17613	lb.	.54 / .84
BCU-40	lb.	.18 / .48
BR-11938	lb.	.285 / .585
Bonding resins, abrasives	lb.	.20 / .915
Brake linings	lb.	.215 / .6275
Foundry resins	lb.	.2075 / .395
Heat Insul. resins	lb.	.1425/ .37
CD Cement Nos. 200, 201, 202, 203, 204	gl.	.94 / 1.50
PS-7	gl.	2.12 / 2.90
Epon Adhesive VI, VIII	lb.	3.08 / 3.30
IX	lb.	4.25 / 4.50
Epoxy Adhesive A-1, A-3, A-4	gl.	4.45 / 6.90
A-2, A-5	gl.	5.60 / 8.00
A-6	gl.	5.80 / 8.00
C-1, C-2, C-3, C-9	gl.	5.60 / 8.00
C-4, C-7	gl.	3.69 / 5.30
Flexible Resin No. 1	gl.	4.45 / 6.90
G-E 12316	lb.	.30 / .39
12353	lb.	.225 / .385
Melmac 401	lb.	.45
421	lb.	.45 / .47
Melurac 300, 302	lb.	.25 / .29
301	lb.	.28 / .33
Metlbond 2002-14	gl.	1.84 / 5.00
4021 Type I	sq. ft.	1.43
Type II	gl.	1.29 / 3.20
Type III	gl.	1.49 / 3.50
Plaskon Phenolic Bonding Resin	lb.	.16 / .21
Urea Adhesive 530-11L	lb.	.1875/ .2175
Liquid Adhesive, 2L Types	lb.	.105 / .115
WR Types	lb.	.0675/ .125
Spray Dried Adhesives	lb.	.18 / .29
Plastic Cement	gal.	2.25 / 2.70
Pliobond 20	gal.	4.50 / 7.00
30	gal.	5.25 / 8.00
Polyester Foam Cement PC-232	gal.	2.40 / 2.90
Schenectady SP-7401	lb.	.29 / .31
Schwartz Vinyl Cement	gl.	1.24 / 1.50
Synvarite US #1	lb.	.195 / .215
Synvarol T	lb.	.125 / .16
T-3	lb.	.0875/ .1225
T-15, T-15D	lb.	.1275/ .1625
TN, TUN	lb.	.1325/ .1675
TN-23	lb.	.14 / .175
WR-513	lb.	.0875/ .1225
WR-515	lb.	.0825/ .1175
WR-520	lb.	.0625/ .0925
Styrofoam Adhesive #5	gal.	3.75 / 4.75
Thixon CB	gal.	3.30 / 3.70
CB-2	gal.	3.75 / 3.95
IB	gal.	3.75 / 4.15
NB	gal.	4.05 / 4.45
NM-2	gal.	7.20 / 8.00
Urac 110	lb.	.205 / .225
115	lb.	.24 / .26
180	lb.	.095 / .12
185	lb.	.1625/ 2175
186	lb.	.0875/ .1125
192	lb.	.07

Anti-Static Agents

Anstac-2M	gl.	1.75 / 2.00
Logostat	gal.	1.35 / 1.65
Merix Anti-Static #79	gl.	.75 / 3.85
#79-OL	gl.	.75 / 3.85

Catalysts

Advasol	lb.	.4375/ .5375
Aritemp Curing Agent 105	lb.	2.00 / 2.25
Bakelite BH-17618	lb.	.33 / .63
DHU-53	lb.	.15 / .45
ERL series	lb.	.67 / 1.195
Cadet benzoyl peroxide, granules	lb.	$0.98 / $2.00
Paste	lb.	.95 / 2.25
Powder	lb.	1.50 / 2.37
Dichlorobenzoyl peroxide	lb.	3.00 / 4.25
Lauroyl peroxide	lb.	1.90 / 3.50
Methyl ethyl ketone peroxide	lb.	1.85 / 4.00
Catalyst 57	lb.	.12
196	lb.	.10
C-110, -180, -180-S, C-110-S, WF-100, -101	lb.	.12
Celanese accelerators D & E	lb.	.43 / .50
Benzol peroxide paste	lb.	2.00
Catalyst MC-1	lb.	2.25 / 2.50
Epon Curing Agent BF_3-400	lb.	4.00 / 4.50
C-111	lb.	.6225/ 1.10
D	lb.	3.33 / 4.75
T	lb.	.80 / 1.11
U	lb.	.86 / 1.02
Z	lb.	1.265 / 1.56
Furane H-736-A	lb.	1.30 / 2.00
Marblette Hardener 11	lb.	1.17 / 1.65
16, 661, 680	lb.	1.25 / 1.70
20	lb.	1.17 / 1.40
21	lb.	1.27 / 1.40
41, 665	lb.	1.32 / 1.77
175, 179	lb.	.50 / .65
645H	lb.	1.15 / 1.70
681, 901	lb.	1.20 / 1.80
900, 903	lb.	2.10 / 2.50
H C Promoter 6%	lb.	.5275/ .6275
12%	lb.	.9025/ 1.0025
Het anhydride	lb.	.55
HN 551	lb.	.95 / 1.40
901	lb.	.36 / .80
951 Ciba	lb.	.82 / 1.32
951 Furane	lb.	1.30 / 2.00
IC activators		3.00
Inhibitor		.98
Melurac 255, 259	lb.	.35
Modifier CB-110, WF-61	lb.	.15
P-27	gal.	10.00
Plaskon Hardeners, Liquid	lb.	.07
Powdered	lb.	.10 / .46
Spray dried	lb.	.10 / .25
Promoter D-2	lb.	1.60 / 2.00
Quick-Set Accelerator 804	gal.	9.80
Rezolin epoxy hardeners	lb.	1.14 / 2.50
SA Hardener	lb.	.10
Soligen	lb.	.4825/ .5825

Coating Resins

Acryloids	lb.	.30 / .87
Amberlacs	lb.	.2625/ .2875
Amberols, phenolic types	lb.	.2125/ .375
Rosin maleic types	lb.	.21 / .345
Bakelite Phenolics	lb.	.28 / .64
Styrene emulsions	lb.	.1375/ .31
Vinyl acetates	lb.	.295 / .66
Solutions	gal.	5.10
Alcohols	gal.	2.27 / 2.76
Butyral resins	lb.	1.04 / 1.24
Chlorides	lb.	.41 / .61
Chloride-acetates	lb.	.38 / .66
Modified	lb.	.44 / .72
Celanese PVA emulsions, homopolymers	lb.	.17 / .26
Copolymers	lb.	.19 / .28
Chemigum latices	lb.	.46 / .60
Cymel 243-3	lb.	.38 / .385
245-8	lb.	.34 / .345
247-10	lb.	.385 / .39
248-8	lb.	.365 / .37
Dylex K-500, -600, -700, -900	lb.	.30 / .46
G-E 13110	lb.	.30 / .39
G.M.I. Polyamids 100	lb.	.51 / .64
115	lb.	.54 / .77
Kel-F Dispersion (dry wt.)	lb.	12.00
Ladcote FHHF-4010, FVHF-4010	lb.	$0.3575/ $0.4075
Plaskon Alkyds	lb.	.1075/ .3375
Modified	lb.	.15 / .2625
Ester Gums	lb.	.1425/ .2475
Maleics	lb.	.1825/ .275
Melamines	lb.	.195 / .435
Phenolics	lb.	.3925/ .475
Modified	lb.	.1825/ .29
Phenolic Laminating Varnishes	lb.	.165 / .27
Silicone Alkyds	lb.	1.10 / 2.40
Ureas	lb.	.195 / .435
Pliolite latices	lb.	.30 / .39
Pliolite N R	lb.	.93 / 1.22
S-3	lb.	.42 / .44
S-5	lb.	.49 / .51
Milled	lb.	.54 / .56
S-7	lb.	.88 / 1.01
Polyfluoron liquid dispersions	lb.	2.65 / 3.85
Paste dispersions	lb.	4.20 / 4.40
Primer 140	qt.	7.88 / 8.25
Schenectady Alkyds SA Type	lb.	.3575/ .38
SE Type	lb.	.3675/ 1.435
SEA Type	lb.	.3575/ .38
Styrenated	lb.	.22 / .2625
Maleics	lb.	.1725/ .23
Phenolics	lb.	.2325/ .53
Modified	lb.	.1825/ .275
Schwartz AT-25	qt.	.63 / 1.00
BK-40	gal.	3.80 / 3.95
Synvaren 631	lb.	.18 / .215
PLS-1	lb.	.455 / .49
PLS-2	lb.	.42 / .455
PLS-22	lb.	.415 / .45
PLSA	lb.	.57 / .605
PLSAA	lb.	.745 / .78
PLSR	lb.	.775 / .81
Synvarite BRLD	lb.	.40 / .46
Versamid 100	lb.	.51 / .69
115	lb.	.64 / .82

Colors

Acheson 0100 Series Paste Dispersions:		
Blacks	lb.	.50 / .81
Blues	lb.	.55 / 2.175
Green	lb.	2.51 / 2.69
Orange	lb.	.67 / .85
Reds	lb.	1.08 / 1.34
White	lb.	.52 / .70
Yellows	lb.	.57 / .75
Advabrite M-10	lb.	2.25 / 2.40
Advance Brightener M.D.A.C.	lb.	12.00 / 15.00
Akron Chemical Colors:		
Dry blends, reds	lb.	1.08 / 1.23
Yellows	lb.	.58 / .88
Organic colors, blues	lb.	.75 / 3.60
Greens	lb.	1.35 / 3.95
Reds	lb.	1.10 / 4.40
Yellows	lb.	2.00 / 5.00
Pastes, blues	lb.	1.25 / 1.58
Greens	lb.	1.85 / 1.90
Reds	lb.	1.10 / 1.40
White	lb.	.55 / .60
Yellows	lb.	1.70 / 1.75
Aquablak No. 1	lb.	.1925/ .1975
41	lb.	.34 / .345
B	lb.	.0975/ .1025
G, K	lb.	.12 / .125
H	lb.	.20 / .205
L	lb.	.14 / .145
M	lb.	.105 / .11
S	lb.	.1175/ .1225
U	lb.	.225 / .23
X	lb.	.11 / .115
Cabot carbon blacks:		
Black pearls 2	lb.	.70 / .78
71	lb.	.32 / .40
74	lb.	.24 / .32
81	lb.	.084 / .135
0	lb.	.12 / .19
Carbolac 2	lb.	.70 / .79
Elf 0	lb.	.12 / .19
Elftex 3, 5, 8	lb.	.085 / .135
Monarch 71	lb.	.32 / .40
74	lb.	.24 / .32
81	lb.	.095 / .16
Sterling R	lb.	.0525/ .0925
S	lb.	.045 / .0875
Supercarbovar	lb.	.47 / .54
Cadmolith Reds	lb.	1.72 / 2.20
Yellows	lb.	1.12 / 1.20
California Ink, P. C. color dispersions:		
Black	lb.	.76 / .77
Blues	lb.	.90 / 2.17
Brown	lb.	.56 / .57
Green	lb.	2.05 / 2.06
Reds	lb.	.61 / 2.67
White	lb.	.72 / .73
Yellows	lb.	.62 / .74
P. C. plasticized boat colors:		
Black	lb.	.76 / .77
Blue	lb.	1.32 / 1.33
Blue-green	lb.	1.21 / 1.22
Green	lb.	2.12 / 2.13
Red	lb.	2.69 / 2.70
Yellow	lb.	1.71 / 1.71

Claremont 4000-Series Pastes:			
Blacks	lb.	$0.82 /	$1.01
Blue	lb.	.80	
Browns	lb.	.65 /	2.30
Greens	lb.	.80 /	2.15
Orange	lb.	1.58	
Reds	lb.	5.60 /	6.95
Silver	lb.	1.02	
White	lb.	.715	
Yellows	lb.	.65 /	2.87
D-Series pastes,			
Blacks	lb.	.48 /	.64
Blues	lb.	.62 /	1.57
Browns	lb.	.48 /	1.67
Golds	lb.	2.31 /	2.49
Green	lb.	1.78 /	1.88
Oranges	lb.	.71 /	4.27
Reds	lb.	1.10 /	6.36
Silver	lb.	.89 /	.91
Whites	lb.	.47 /	.60
Yellows	lb.	.56 /	3.70
K-Series pastes,			
Blacks	lb.	.56 /	.71
Blues	lb.	.89 /	1.40
Browns	lb.	.53 /	.55
Greens	lb.	.92 /	1.41
Metallics	lb.	.89 /	2.47
Orange	lb.	.86 /	4.45
Reds	lb.	.99 /	6.85
Violets	lb.	2.28 /	2.30
Whites	lb.	.59 /	.60
Yellows	lb.	.72 /	3.02
MB-Series inks:			
Black	lb.	.85	
Blue	lb.	1.25	
Clears	lb.	.65 /	.66
Green	lb.	1.30	
Metallics	lb.	1.20 /	1.25
Orange	lb.	1.05	
Pearl	lb.	1.17	
Red	lb.	1.11	
White	lb.	.68	
Yellows	lb.	.90 /	1.23
Mylar printing inks:			
Aluminum	lb.	.99	
Black	lb.	.81	
Blue	lb.	1.18	
Bronze reducing clear	lb.	.51	
Gold concentrate	lb.	1.07	
Green	lb.	1.27	
Hi-viscosity clear	lb.	.69	
Orange	lb.	.97	
Pearlescent concentrate	lb.	1.98	
Red	lb.	1.19	
Reducing clear	lb.	.68	
White	lb.	.53	
Yellows	lb.	.83 /	1.21
PE-Series, granular concentrates:			
Blacks	lb.	.86 /	1.05
Blues	lb.	2.98	
Green	lb.	3.00	
Metallics	lb.	1.27 /	1.66
Oranges	lb.	1.12 /	2.75
Reds	lb.	1.93 /	5.25
Whites	lb.	.70 /	.85
Yellows	lb.	.78 /	5.10
PX-Series pastes:			
Black	lb.	1.58 /	1.68
Blue	lb.	2.50 /	2.60
Browns	lb.	1.06 /	1.47
Green	lb.	2.76 /	2.86
Grey	lb.	1.30 /	1.40
Ochre	lb.	1.27 /	1.37
Orange	lb.	1.48 /	1.58
Silver	lb.	1.45 /	1.55
White	lb.	.91 /	1.01
Yellows	lb.	1.58 /	2.55
RP-Series inks:			
Aluminum	lb.	.89	
Black	lb.	.58	
Blue	lb.	1.08	
Gold	lb.	.95	
Green	lb.	1.12	
Orange	lb.	.83	
Pearlescent	lb.	1.87	
Red	lb.	1.08	
Reducing clears	lb.	.47 /	.65
White	lb.	.49 /	
Yellows	lb.	.71 /	1.09
UR-Series pastes:			
Black	lb.	1.00	
Blue	lb.	1.82	
Brown	lb.	2.00	
Green	lb.	2.20	
Orange	lb.	1.68	
Reds	lb.	1.92 /	3.55
White	lb.	.83	
Yellows	lb.	1.75 /	2.15
VC-Series Inks:			
Black	lb.	.94	
Blue	lb.	1.20	
Clear	lb.	.49	
Green	lb.	1.30	
Metallics	lb.	1.09 /	1.45
Orange	lb.	.95	
Pearl	lb.	1.45	
Red	lb.	1.05	
White	lb.	.70	
Yellows	lb.	.85 /	.98
Coloidex No. 3	lb.	.24	
Columbian Carbon bone blacks:			
Ivo No. 1	lb.	.1975/	.2175
3	lb.	.1875/	.2075
4	lb.	.16 /	.18
100	lb.	.2075/	.2275
359	lb.	$0.2025/	$0.2225
457	lb.	.1925/	.2125
Carbon blacks:			
#140, #140 densed, Paris II, Raven 11, 15	lb.	.0975/	.175
Molacco, Statex Beads	lb.	.0575/	.12
Molacco Beads	lb.	.0525/	.11
Paris Beads, Raven Beads	lb.	.0865/	.155
Raven 15 Beads, States X Beads	lb.	.0725/	.14
Statex, Statex B-12 Beads	lb.	.0675/	.125
Statex B-12, B-12A, F-12	lb.	.0775/	.135
Colloidal dispersions:			
Coacetateblak CQ-21	lb.	.875 /	.90
CoblacDD Sol. Industrial	lb.	.70 /	.725
Coethloblak CK	lb.	1.00 /	1.025
Coresinblak No.3	lb.	.76 /	.785
Costyreneblak CJ-21	lb.	.5425/	.5675
Covarnishblak AR	lb.	.60 /	.625
BJ	lb.	.50 /	.525
BK	lb.	.53 /	.555
Covinylblak BA	lb.	.95 /	.975
BD	lb.	.97 /	.995
BF	lb.	.70 /	.725
BH	lb.	.66 /	.685
BL	lb.	.82 /	.845
BM	lb.	.77 /	.795
CA-18	lb.	1.0725/	1.0975
Cowaxblak BV-25	lb.	.515 /	.54
CB-18	lb.	.5875/	.6125
CM-83	lb.	.485 /	.51
Cyanamid inorganic pigments:			
Cobalt blues	lb.	.28 /	.35
Chrome greens	lb.	.42 /	.47
Oranges	lb.	.35	
Yellows	lb.	.35	
Iron blues	lb.	.54/	.59
Molybdate chrome oranges	lb.	.48	
Ultramarine blues	lb.	.19 /	.325
Zinc yellow	lb.	.29	
Powders, Unitane-O	lb.	.245 /	.26
Unitane-OR	lb.	.265 /	.28
Organic dyes, Indulines	lb.	.89 /	1.07
Nigrosines	lb.	.65 /	.94
Oil-soluble black	lb.	.68	
Blue	lb.	8.02	
Orange	lb.	1.06	
Reds	lb.	1.49 /	2.28
Yellows	lb.	1.21 /	4.16
Spirit-soluble black	lb.	2.95	
Brown	lb.	5.30	
Orange	lb.	5.87	
Red	lb.	6.41	
Yellows	lb.	4.62 /	4.94
Pigments, alkali blues	lb.	1.28 /	2.25
Benzidine oranges	lb.	3.15	
Yellows	lb.	.65 /	3.25
Bon reds	lb.	1.50 /	2.00
Carteret red	lb.	.93	
Chlorinated para reds	lb.	1.30	
Clarion orange	lb.	1.65	
Red	lb.	1.30	
Dinitraniline oranges	lb.	1.50	
Fugitive peacock-blue lakes	lb.	.90 /	1.17
Hansa yellows	lb.	2.20	
Lithol reds	lb.	.93 /	.98
Methyl violet toner	lb.	1.31	
Naphthol reds	lb.	.80 /	3.70
Orange lakes	lb.	.85 /	.90
PTMA blue	lb.	5.55	
Greens, Lincoln	lb.	5.30 /	6.60
Violet	lb.	4.35	
Para reds	lb.	1.15	
Phloxine toner	lb.	1.75	
Phthalocyanine blues	lb.	.90 /	4.20
Greens	lb.	3.50 /	3.95
Pigment green	lb.	1.35	
Scarlet	lb.	1.65	
Red Lake C's	lb.	1.20	
Madder	lb.	3.10	
Rhodamines	lb.	6.60	
Toluidine reds	lb.	1.70	
Yellow lakes	lb.	1.05 /	1.15
DC Globak	lb.	.77 /	.795
DCV Coblac	lb.	.83 /	.855
Eagle-Picher Basic carbonate White lead	lb.	.19 /	.20
Basic silicate, white lead 201	lb.	.2075/	.2175
202	lb.	.20 /	.21
Litharge	lb.	.19	
Sublimed	lb.	.1910	
Ferro inorganic colors:			
Black	lb.	1.25 /	1.40
Blues	lb.	1.91 /	2.96
Blue-greens	lb.	1.85 /	2.85
Browns	lb.	.90 /	1.31
Oranges	lb.	2.29 /	4.20
Pink	lb.	1.77 /	1.92
Reds	lb.	2.96 /	4.75
Violets	lb.	1.89 /	2.37
Yellows	lb.	1.26 /	2.90
Harwick Stan-Tones, blues, cadmium dry	lb.	1.95 /	2.15
Dry	lb.	.90 /	5.00
GPE	lb.	1.90 /	2.57
MBS	lb.	1.55 /	4.62
PC	lb.	1.80 /	1.92
Brown, GPE	lb.	3.00	
Greens, dry	lb.	.82 /	3.95
GPE	lb.	3.00 /	4.57
MBS	lb.	1.55 /	3.42
PC	lb.	2.20 /	2.25
Pastes	lb.	1.55 /	1.70
Maroon, dry	lb.	$5.50	
Oranges, cadmium dry	lb.	2.23 /	5.05
Paste	lb.	2.65 /	3.65
GPE	lb.	1.20 /	4.42
MBS	lb.	2.75 /	2.82
PC	lb.	.75 /	3.25
Reds, cadmium dry	lb.	2.49 /	6.15
Paste	lb.	3.35 /	3.95
Dry	lb.	.85 /	4.60
GPE	lb.	1.65 /	3.00
MBS	lb.	1.00 /	3.60
PC	lb.	1.10 /	3.57
Yellows, cadmium dry	lb.	2.80 /	3.18
Paste		1.63 /	2.19
Dry	lb.	.62 /	2.35
GPE	lb.	2.00 /	4.57
MBS	lb.	1.30 /	2.27
PC	lb.	1.65 /	3.57
Hiblak AE	lb.	.095 /	.10
Interchemical IC Series			
Black	lb.	.56	
Blues	lb.	.75 /	2.10
Browns	lb.	.64 /	.69
Greens	lb.	.90 /	.99
Oranges	lb.	.78 /	.89
Reds	lb.	1.16 /	2.50
White	lb.	.70	
Yellows	lb.	.95 /	1.65
Kentucky inorganics, orange	lb.	.44 /	.64
Yellows	lb.	.31 /	.66
Organics,	lb.	3.00 /	4.15
Greens	lb.	3.50 /	4.60
Purple	lb.	1.83 /	2.05
Reds	lb.	1.95 /	3.85
Krieg-O-Dip W Types	qt.	2.63 /	7.80
A Types	qt.	1.52 /	2.25
Laminac color pastes	lb.	.76 /	1.90
Mapico colors, black	lb.	.1425/	.145
Browns	lb.	.1525/	.155
Reds	lb.	.1375/	.14
Tans	lb.	.2275/	.23
Yellows	lb.	.115 /	.1225
Mearlmaid Pearls	lb.	14.00 /	25.00
Nacromer Pearls, Series C	lb.	2.15 /	2.25
Series W	lb.	1.50 /	1.60
Pearl Essence, nat	lb.	15.00 /	30.00
Synthetic #100	lb.	1.95	
#300	lb.	1.45	
#600, #900	lb.	2.15 /	2.45
Plastics Color Co., GP colors:			
Blacks	lb.	.75 /	3.80
Blues	lb.	.445 /	.48
Brown	lb.	1.20 /	2.25
Greens	lb.	.65 /	3.50
Reds	lb.	.65 /	3.50
Whites	lb.	.75 /	1.10
Yellows	lb.	1.15 /	1.95
Polyester pastes, aqua	lb.	1.65	
Beige	lb.	1.45	
Black	lb.	1.10	
Blues	lb.	1.20 /	1.30
Brown	lb.	1.35	
Greens	lb.	1.20 /	1.70
Grey	lb.	1.30	
Ivory	lb.	1.30	
Oranges	lb.	1.80 /	2.05
Red	lb.	2.35	
White	lb.	.80	
Yellow	lb.	1.60	
Pliolite S-5 bases with pigment			
Blacks	lb.	.44 /	.40
Blues	lb.	.62 /	1.48
Greens	lb.	.54 /	.58
Oranges	lb.	.61 /	.63
Reds	lb.	.31 /	1.20
Whites	lb.	.42 /	.44
Yellows	lb.	.43 /	.45
PMS polyester colors	lb.	.85 /	2.85
Polystyrene colors	lb.	.65 /	4.30
Polysunra polyethylene blues	lb.	.65 /	5.60
Blacks	lb.	.50 /	.80
Browns	lb.	1.48 /	3.30
Greens	lb.	1.82 /	3.55
Ivory	lb.	.65 /	1.00
Purples	lb.	2.10 /	3.30
Reds	lb.	.70 /	6.30
Silver	lb.	1.50 /	2.95
White	lb.	.60 /	.85
Yellow	lb.	1.45 /	4.25
Polystyrene blues	lb.	.50 /	9.20
Blacks	lb.	.50 /	5.30
Browns	lb.	.95 /	2.55
Greens	lb.	.35 /	7.40
Ivory	lb.	.85 /	1.20
Reds	lb.	.35 /	6.40
White	lb.	.60 /	1.05
Yellows	lb.	1.45 /	2.95
R-B-H Plastic Powders:			
Blacks	lb.	.71 /	.79
Blues, iron	lb.	.875	
Phthalocyanines	lb.	2.73	
Browns	lb.	.61 /	.8
Greens, chrome	lb.	.855	
Phthalocyanines	lb.	2.34	
Orange	lb.	.87	
Purple	lb.	3.00	
Red	lb.	1.93	
Whites	lb.	.71 /	.74
Yellow	lb.	.81	
Resin Plasticizer Pastes:			
Blacks	lb.	.505 /	.63
Blue	lb.	1.59	
Green	lb.	1.58	
Orange	lb.	.665	

Reds	lb.	$1.15 /	$2.24
White	lb.	.50	
Yellows, cadmium	lb.	1.20	
Chrome	lb.	.545	
Vinyl Extrusion Chips:			
Blacks	lb.	.975 /	1.04
Blues, iron	lb.	.90 /	1.08
Phthalocyanine	lb.	2.50	
Brown	lb.	.86	
Green, chrome	lb.	.96	
Phthalocyanine	lb.	2.51	
Oranges	lb.	.875 /	.92
Purple	lb.	3.41	
Reds	lb.	1.38 /	2.02
White	lb.	.78	
Yellow	lb.	.845	
R-C blacks	lb.	5.50 /	21.30
Browns	lb.	4.375 /	15.75
Reds	lb.	.28 /	15.05
Yellows	lb.	3.60 /	14.05
Rez-N-Dye (dry wt.)	lb.	7.50	
Saran colors	lb.	.59 /	1.80
Sherwin-Williams Dispersed Colors	lb.	.55 /	1.97
Inorganic colors, oranges, yellows	lb.	.32 /	.45
Organic colors, blues	lb.	.90 /	3.60
Greens	lb.	1.35 /	3.95
Reds	lb.	.85 /	4.40
Yellows	lb.	.55 /	1.97
Vansul Organic Drys			
Blues	lb.	3.45 /	3.60
Greens	lb.	1.35 /	3.95
Oranges	lb.	2.21 /	3.00
Reds	lb.	.90 /	4.40
Yellows	lb.	2.00 /	2.25
VAP Dry Dispersions			
Black	lb.	1.00	
Blues	lb.	2.90 /	3.60
Greens	lb.	3.20 /	4.05
Oranges	lb.	1.45 /	2.55
Reds	lb.	1.70 /	4.45
Yellows	lb.	1.35 /	2.55
VP-Series Pastes			
Black	lb.	.70	
Blue	lb.	1.65	
Brown	lb.	1.55	
Green	lb.	2.05	
Oranges	lb.	.80 /	2.30
Reds	lb.	1.15 /	2.55
White	lb.	.47 /	.65
Yellows	lb.	.60 /	1.65
VPE-Series Pastes			
Black	lb.	.90	
Blue	lb.	1.85	
Green	lb.	2.10	
Orange	lb.	1.00	
Reds	lb.	1.45 /	2.30
White	lb.	.90	
Yellows	lb.	1.60 /	2.00
VY Chips			
Blacks	lb.	.90 /	1.30
Blues	lb.	1.00 /	2.25
Brown	lb.	1.60	
Greens	lb.	.90 /	2.45
Oranges	lb.	1.00 /	2.15
Reds	lb.	1.40 /	2.70
White	lb.	.65	
Yellows	lb.	.85 /	1.80
Vinylized colors, blacks, whites	lb.	.755	
Blues	lb.	1.16 /	1.18
Golds	lb.	1.51 /	1.57
Green	lb.	1.45	
Metallic	lb.	1.15	
Orange	lb.	.83	
Reds	lb.	1.15 /	2.27
Yellows	lb.	.76 /	1.09
Violite 199, green	lb.	2.95	
200, yellow	lb.	3.75	
PL 3-60, blue	lb.	3.25	
18-70, blue	lb.	3.70	
Williams colors & pigments:			
Blacks, iron oxide	lb.	.1425/	.145
Browns, iron oxide	lb.	.1525/	.155
Burnt umbers	lb.	.0775/	.095
Greens, chromium oxide	lb.	.42 /	.4875
Reds, 100 series, 1,000 series, RY series	lb.	.1375/	.14
Kromas	lb.	.1375/	.15
Yellows, iron oxide	lb.	.115 /	.1225
Witcoblaks	lb.	.075 /	.37
Zopaque, anatase	lb.	.225 /	.235
Rutile	lb.	.245 /	.255

Dispersing Agents

Daxads	lb.	.08 /	.40
Tamol 731	lb.	.185 /	.1875

Fillers

Advaresin CXF	lb.	.49 /	.55
KF	lb.	.38 /	.44
A. F. D.	ton	26.50 /	60.00
Albacar 5950, 5960, 5970	ton	50.00 /	55.00
Aluminum Flake	ton	23.50 /	30.00
Anhydrous calcium sulfate, W-1320	ton	47.00 /	52.00
Atomite	ton	32.50	
Barytes, No. 1	ton	45.00 /	65.75
Burgess Iceburg Pigment	ton	50.00	
Pigment No. 30	ton	37.00	
Cab-o-sil	lb.	$0.68 /	$0.75
Calcene NC	lb.	.036 /	.059
TM	lb.	.0375/	.0625
Camel—CARB	ton	12.00	
—TEX	ton	20.00	
—WITE	ton	32.50	
Cotton flocks	lb.	.12 /	.32
Crown Clay	ton	14.00	
Dixie Clay	ton	14.00 /	34.50
Duramite	ton	20.00	
Harwick fillers:			
Clays, Champion	ton	14.00	
Harwick	ton	14.50 /	57.00
Flock, white	lb.	.11 /	.28
Colored	lb.	.11 /	.19
Magnesium carbonate	lb.	.105 /	.13
Magnesia, tech	lb.	.105 /	.12
Mica, Silversheen	lb.	.08 /	.0875
Pecan shell flour	ton	80.00 /	100.00
Stan white 325	ton	10.50 /	12.00
Walnut shell flours:			
100W, 200WD	ton	46.00 /	56.00
100WD	ton	40.00 /	50.00
200W	ton	56.00 /	66.00
200WB	ton	59.00 /	69.00
325W	lb.	70.00 /	80.00
Hi-Sil 101	lb.	.10 /	.155
233	lb.	.09 /	.105
Hydrite	ton	22.50	
Flat	ton	22.50	
PD-10	ton	46.50	
Kalite	ton	50.00 /	65.00
Kaolloid	ton	10.50	
Laminar	lb.	.015	
Maglite	lb.	.2525/	.26
Marinco	lb.	.105 /	.13
McMamee Clay	ton	13.50 /	33.00
Minerals & Chemical Corp.:			
Edgar ASP 200	ton	43.00	
ASP 400	ton	24.00	
ASP 600	ton	25.00	
ASP 900	ton	19.50	
ASP 1300	ton	80.00	
Multiflex MM	ton	110.00 /	125.00
Nytal 200L	ton	27.00 /	50.00
300	ton	37.00 /	60.00
Secco Clay	ton	12.00	
Silene EF	lb.	.06 /	.105
Sno-Brite Clay	ton	12.50	
Snowflake	ton	20.00	
Sparmite	ton	80.00 /	105.00
Surtex MM	ton	37.00 /	52.00
Suspenso	ton	33.00 /	48.00
Tamms Satin Talc	ton	22.50 /	46.00
Velveteen R Silica	ton	23.00 /	28.00
Witcarb P	ton	110.00 /	140.00
R	ton	120.00 /	150.00
Regular	ton	56.75 /	85.00
Wollastonite P-1	ton	23.00 /	25.00
P-1	ton	25.00 /	27.00

Finishes

Logoquant colors	gal.	3.25 /	6.30
Toy gloss, acetate	gal.	2.35 /	4.30
Metal	gal.	2.45 /	4.10
Polystyrene	gal.	2.45 /	4.70

Flame-Proofing Agents

IC-776 Antimony Concentrate	lb.	.495 /	.51
M&T Antimony oxide	lb.	.27 /	.285

Glass Reinforcements

Chrome 60-end Roving:			
FBF-7.1, -7.3	lb.	.40 /	.44
FBF-7.5, -7.7	lb.	.42 /	.46
Garan 60-end Roving:			
FBF-7.2, -7.4	lb.	.42 /	.46
FBF-7.6, -7.8	lb.	.44 /	.48
Vitron 60-end Roving:			
VR-12	lb.	.48 /	.52

Lubricants

Advawax 280	lb.	.365 /	.39
Baselube	qt.	2.50 /	4.00
DC-36 Emulsion	lb.	1.36 /	2.50
Garalease 915	gal.	3.80 /	4.50
GE silicone-emulsions	lb.	1.22 /	1.40
HSC #35, 362, 515	lb.	1.22	
IC-500	gal.	2.50	
-571	gal.	3.25	
-793-10	gal.	3.40	
Lunn-Lease	gal.	4.15 /	4.85
M-1 Mold Release	lb.	3.00 /	4.00
Metasap barium stearate	lb.	.37 /	.42
Calcium 627	lb.	.36 /	.41
Stearate	lb.	.35 /	.40
Magnesium stearate	lb.	.38 /	.43
ML-4 Separating Film	lb.	.30 /	.40
Mold-Ease Concentrate PCR	qt.	2.50 /	5.85
Mold Release 225	gal.	5.25 /	6.00
235	gal.	6.00	
Mold-Wiz	gal.	4.00 /	6.00
Part-A-Part	gal.	$3.05 /	$3.75
Partingkote 823	qt.	1.18 /	2.18
Prepoxy	gal.	7.20 /	12.80
Plaskon 8406, 8407	lb.	.30 /	.37
8416, 8417	lb.	.35 /	.42
8429	lb.	.40 /	.47
Releasor Wax No. 826	lb.	2.29	
Slide	20 oz.	1.25 /	2.00
Sprits	lb.	1.00 /	1.25
SS-452	gal.	2.80 /	4.90
Super King Bomb-Lube	20 oz.	1.75 /	2.50
Toplube	qt.	2.50 /	4.00
Vibrin-VPA Parting Agent	gal.	4.25 /	4.65

Mica

Mycalex 385 & 400, rods, 18 in. length		.90 /	3.35
Sheets, 14 x 18 inches		5.70 /	22.40
K, rods, 18-in. length		1.80 /	6.70
Sheets, 14 x 18 inches		11.40 /	44.80
Supramica 500, rods, 18-in. length		1.08 /	4.02
Sheets, 14 x 18 inches		6.84 /	26.88

Miscellaneous

Dutch Boy Bentone	lb.	.44 /	.60
Ben-A-Gel	lb.	.98 /	1.40
Metasap Water Proofing Agent 569	lb.	.21	
PMS Purging Compound	lb.	.35	
Ultra violet absorber #9	lb.	5.25 /	5.75

Plasticizers

Adipol 2EH, 10A, 810, XX	lb.	.40 /	.435
BCA	lb.	.43 /	.455
ODV	lb.	.45 /	.485
Admex 710	lb.	.325 /	.35
711	lb.	.345 /	.37
744, 745	lb.	.40 /	.425
Akron MP	lb.	.305 /	.0755
Battett dibutyl phthalate	lb.	.30 /	.335
Dimethyl phthalate	lb.	.275 /	.315
Plastixizer 136	lb.	.19 /	.235
Benzoflex 2-45	lb.	.26 /	.29
9-88	lb.	.32 /	.35
Cabflex DDA, Di-OA, DOA, ODA	lb.	.425 /	.455
DDP, Di-OP, DOP, ODP	lb.	.305 /	.335
Di-BA	lb.	.4325/	.4625
Di-OZ	lb.	.48 /	.51
HS-10	lb.	.44 /	.47
TCP	lb.	.345 /	.375
Chlorowax 40	lb.	.1525/	.1825
50	lb.	.1675/	.1875
70	lb.	.185 /	.25
70-S	lb.	.21 /	.275
LV	lb.	.1725/	.2025
Columbian Carbon butyl stearate	lb.	.2275/	.32
Capryl alcohol	lb.	.195 /	.30
Caprylene	lb.	.10 /	.205
Dibenzyl sebacate	lb.	.88 /	.965
Dibutyl phthalate, dihexyl phthalate	lb.	.30 /	.395
Dibutyl sebacate, CP	lb.	.64 /	.725
Dicapryl phthalate	lb.	.275 /	.36
Dicapryl sebacate, dioctyl sebacate	lb.	.58 /	.665
Dihexyl adipate, dioctyl adipate, diisooctyl adipate	lb.	.40 /	.495
Dihexyl sebacate	lb.	.62 /	.705
Diisodecyl phthalate	lb.	.275 /	.36
Diisooctyl phthalate, dioctyl phthalate	lb.	.285 /	.38
Dimethyl sebacate	lb.	1.25 /	1.335
Harchemex	lb.	.24 /	.345
Harflex 300	lb.	.58 /	.675
325	lb.	.4325/	.52
500	lb.	.315 /	.41
Isooctyldecyl phthalate	lb.	.29 /	.385
Methyl hexyl ketone	lb.	.26 /	.365
Sebacic acid, CP	lb.	.70 /	.82
Purified	lb.	.64 /	.76
Conoco H-300	lb.	.06 /	.10
Darex DIBA	lb.	.4325/	.4625
DIBM	lb.	.32 /	.3475
DIBP	lb.	.30 /	.33
DODA, DIOA	lb.	.425 /	.455
DIDP, DIOP, DOP, DOP-HR, IOIDP	lb.	.305 /	.335
Dinopol 235	lb.	.355 /	.385
IDO	lb.	.305 /	.335
MOP	lb.	.325 /	.355
Dow Plasticizer No. 5	lb.	.315 /	.54
Resin 276-V2, -V9	lb.	.265 /	.325
Drapex 3.2	lb.	.40 /	.49
Drew DP-100, DP'200	lb.	.425 /	.46
DP-250	lb.	.435 /	.47
DP-316	lb.	.30 /	.335
DP-317	lb.	.5625/	.5975
DP-520	lb.	4225/	.4575
SC	lb.	.44	
Dutch Boy Plasticizer NL-A10 (DBP)	lb.	.30	.33
NL-A20 (DOP), NL-A30 (DIOP)	lb.	.305 /	.335
NL-C20 (DOS)	lb.	.61 /	.63
NL-F21	lb.	.395 /	.425

NL-F31	lb.	$0.44 /	$0.47
NL-F41	lb.	.48 /	.51
NL-A54	lb.	.295 /	.325
Elastex 10-P, 28-P	lb.	.285 /	.32
18-P	lb.	.29 /	.325
20-A, 60-A	lb.	.40 /	.435
40-P, 48-P	lb.	.27 /	.305
50-B	lb.	.265 /	.30
80-P	lb.	.275 /	.31
90-P	lb.	.295 /	.33
DCHP	lb.	.59 /	.605
Ethox	lb.	.50 /	.525
Flexol 3GH	lb.	.44 /	.46
3G0	lb.	.53 /	.55
4G0	lb.	.325 /	.355
8N8	lb.	.355 /	.385
10-10	lb.	.295 /	.33
77-G, 426	lb.	.27 /	.30
810	lb.	.29 /	.325
B-400	lb.	.25 /	.28
CC-55	lb.	.305 /	.34
DOP	lb.	.285 /	.32
R2H	lb.	.59 /	.595
T0F	lb.	.435 /	.475
Flexricin 66	lb.	.3275	
P-4		.30	
P-6	lb.	.37	
P-8	lb.	.32	
Good-Rite GP-233, -235, -236	lb.	.40 /	.435
GP-261	lb.	.285 /	.32
GP-265	lb.	.29 /	.325
GP-266	lb.	.295 /	.33
Harflex 10	lb.	1.25 /	1.335
40	lb.	.64 /	.725
50, 80	lb.	.58 /	.665
60	lb.	.62 /	.705
90	lb.	.88 /	.965
120, 150	lb.	.305 /	.395
140, 160	lb.	.30 /	.39
180	lb.	.295 /	.38
220, 250	lb.	.425 /	.515
260, 280	lb.	.42 /	.51
300	lb.	.58 /	.67
500	lb.	.315 /	.405
Harchem butyl stearate	lb.	.2275/	.3125
Sebacic acid, CP	lb.	.67 /	.79
Purified	lb.	.59 /	.71
Kapsol	lb.	.3225/	.3525
Kessco flex 103	lb.	.36 /	.38
BCL	lb.	.355 /	.375
BCO	lb.	.345 /	.365
BCP	lb.	.33 /	.36
BO	lb.	.26 /	.28
BS	lb.	.23 /	.25
DBT	lb.	.61 /	.64
DIA	lb.	.44 /	.47
DIOA, DOA	lb.	.40 /	.43
MCO	lb.	.335 /	.355
MCS	lb.	.32 /	.34
TRA	lb.	.37 /	.40
KP-23	lb.	.29 /	.32
-90	lb.	.40 /	.435
-140	lb.	.46 /	.485
-201	lb.	.5825/	.5925
-220	lb.	.31 /	.345
-555	lb.	.46 /	.485
Kronisol	lb.	.33 /	.365
Kronitex AA, I, K-3, MX	lb.	.345 /	.38
Methox	lb.	.385 /	.41
Monoplex DBS	lb.	.64 /	.665
DCP	lb.	.2925/	.32
DOS	lb.	.58 /	.605
S-38	lb.	.215 /	.24
S-70	lb.	.3925/	.42
S-71	lb.	.45 /	.475
Monsanto dibutyl phthalate	lb.	.30 /	.33
Diethyl phthalate	lb.	.25 /	.28
Dimethyl phthalate	lb.	.275 /	.305
Diphenyl phthalate	lb.	.5175/	.5375
DIDA, DOA	lb.	.425 /	.455
DIDP, DIOP, DOP	lb.	.305 /	.335
HB-20	lb.	.15 /	.17
HB-40	lb.	.22 /	.24
Orthonitrobiphenyl	lb.	.13 /	.15
Tricresyl phosphate	lb.	.33 /	.36
Triphenyl phosphate	lb.	.39 /	.40
Morflex P-50	lb.	.68 /	.71
Naugatuck decylbutyl phthalate	lb.	.27 /	.30
Dibutyl phthalate	lb.	.30 /	.33
Sebacate	lb.	.645 /	.67
Diisooctyl adipate, dioctyl adipate	lb.	.425 /	.455
Diisooctyl phthalate, dioctyl phthalate, Isooctyl decyl phthalate	lb.	.305 /	.335
Dinonyl adipate	lb.	.445 /	.475
Dioctyl sebacate	lb.	.585 /	.61
Epoxy plasticizer	lb.	.335 /	.36
Tricresyl phosphate	lb.	.345 /	.375
Ohio-Apex butyl oleate	lb.	.2325/	.265
Stearate	lb.	.22 /	.255
Diallyl phthalate	lb.	.49 /	.525
Dibutyl phthalate	lb.	.30 /	.335
Di-Carbitol phthalate	lb.	.40 /	.425
Diisobutyl adipate	lb.	.41 /	.445
Diisodecyl phthalate	lb.	.305 /	.34
Dioctyl phthalate	lb.	.305 /	.34
D.I.O.P.	lb.	.305 /	.34
Tributyl phosphate	lb.	.50 /	.535
Ohopex Q-10	lb.	.295 /	.33
R-9	lb.	.3525/	.3775
Paraplex S-B	lb.	.29 /	.3475
AL-111	lb.	.32 /	.3275
G-20	lb.	.76 /	.7675
G-25	lb.	.76 /	.77
G-40	lb.	$0.4825/	$0.51
G-50	lb.	.39 /	.4175
G-53	lb.	.4325/	.46
G-60, -61	lb.	.3325/	.36
G-62	lb.	.3525/	.38
RG-2	lb.	.41 /	.6575
RG-7	lb.	.33 /	.335
RG-8	lb.	.505 /	.5125
RG-10	lb.	.52 /	.5275
Pfizer acetyl tributyl citrate, tech	lb.	.32 /	.57
Acetyl triethyl citrate, tech	lb.	.36 /	.57
Triethyl citrate	lb.	.4575/	.58
Plasticizer 1	lb.	1.17 /	1.37
Plasticizer 120	lb.	.44 /	.49
Plastoflex #3	lb.	.52 /	.57
#520	lb.	.36 /	.435
D B E	lb.	.50 /	.55
MGB	lb.	.29 /	.37
VS	lb.	.3575/	.3975
Plastolein 9050 DHZ	lb.	.52 /	.56
9055 DGP	lb.	.28 /	.32
9057 DIOZ	lb.	.455 /	.50
9058 DOZ	lb.	.455 /	.50
9250 THFO	lb.	.3575/	.4025
9404 TGP	lb.	.3725/	.4175
9715 & 9720 Polymeric	lb.	.365 /	.41
Polycizer 162	lb.	.285 /	.32
332, 532, 632	lb.	.40 /	.43
562	lb.	.29 /	.325
662, 662-BPA	lb.	.295 /	.33
Polycon #7, 9, 10, 11	lb.	.305 /	.335
#30	lb.	.30 /	.33
#31	lb.	.27 /	.30
#40	lb.	.245 /	.275
PX-104	lb.	.30 /	.33
-108, -118, -120, -138	lb.	.305 /	.335
-114	lb.	.27 /	.30
-208, -220, -238	lb	.425 /	.455
-404	lb.	.645 /	.67
-438	lb.	.585 /	.61
-800	lb.	.325 /	.35
-917	lb.	.33 /	.36
Pycal 40	lb.	.3875/	.4375
60	lb.	.60 /	.635
62	lb.	.80 /	.835
94	lb.	.3275/	.3775
140	lb.	.35 /	.40
170	lb.	.275 /	.325
194	lb.	.2775/	.3275
R C Plasticizers:			
B-17	lb.	.21 /	.33
BD-8	lb.	.38 /	.50
BIDP	lb.	.27 /	.42
DBP	lb.	.30 /	.44
DIDA, DIOA, DOA	lb.	.425 /	.56
DIDP, DIOP, DOP, ODP	lb.	.305 /	.45
DIOS, DOS	lb.	.58 /	.71
O-16	lb.	.275 /	.395
TG-8	lb.	.31 /	.43
TG-9	lb.	.41 /	.53
Santicizer 1-H	lb.	.50 /	.51
3	lb.	.46 /	.47
8	lb.	.43 /	.44
9	lb.	.39 /	.42
140	lb.	.33 /	.36
141	lb.	.34 /	.37
160	lb.	.25 /	.28
601	lb.	.32	
602	lb.	.305	
B-16	lb.	.4875/	.4975
E-15	lb.	.5075/	.5375
M-17	lb.	.4275/	.4375
Stafiex AX	lb.	.43	
BR	lb.	.26 /	.29
CP	lb.	.28 /	.31
DBES, DOS	lb.	.61 /	.635
DIOA, ODA	lb.	.435 /	.465
DIOP, DOP, MP	lb.	.305 /	.335
DOZ	lb.	.48 /	.5075
IXA	lb.	.32 /	.35
KA	lb.	.36 /	.3875
KD	lb.	.44 /	.4675
Witcizer #100	lb.	.26 /	.27
#101	lb.	.31 /	.32
#200	lb.	.195 /	.205
#201	lb.	.235 /	.245
#300	lb.	.30 /	.33
#312, 313	lb.	.305 /	.33
#412	lb.	.435 /	.465

Resins & Molding Compounds

Acrylic

Cadco cast rods	lb.	1.42 /	6.96
Polished	lb.	1.58 /	7.16
Machined rods	ft.	22.00 /	89.54
Tubes	lb.	1.39 /	5.76
Polished	lb.	1.51 /	5.99
Colors	lb.	1.62 /	5.99
Pearl	lb.	1.99 /	6.76
Lucite injection molding powders:			
Colorless, transparent	lb.	.55	
Std. colors	lb.	.59 /	1.00
Stock colors	lb.	.59 /	.84
Granular Powders for compression & extrusion	lb.	.51 /	.75
Plexiglas molding powders:			
Colorless	lb.	.55 /	.80
Colors, stock	lb.	.59 /	.84
Custom	lb.	.59 /	1.00
Sheets, Types I-A & II			
Colorless	sq. ft.	$0.80 /	$22.18
Colors	sq. ft.	.88 /	1.10
Type R, Colorless	sq. ft.	.60 /	12.64
Colors	sq. ft.	.69 /	1.07
Polycast 1	sq. ft.	.80 /	2.40

Alkyd

Plaskon foundry resin 580-11L	lb.	.245 /	.275
Molding Compound, Type 411	lb.	.43 /	.60
Type 413, 417	lb.	.57 /	.74
Type 420 black	lb.	.44 /	.69
Type 422 colored	lb.	.51 /	.69
Mottle	lb.	.52 /	.70
Natural	lb.	.49 /	.60
Type 430	lb.	.34 /	.50

Cellulosic

Cellulose acetate:			
Ampacet Group I	lb.	.50 /	.59
Group II	lb.	.46 /	.55
Group III			
Colors	lb.	.50 /	.59
Metallic	lb.	.63 /	.71
Pearl	lb.	.59 /	.68
Phosphorescent	lb.	.80 /	.89
Celanese film rolls			
Clear	lb.	.64 /	.87
Colors	lb.	.88 /	1.74
Sheets			
Clear	M. sq. in.	.032 /	.107
Colors	M. sq. in.	.042 /	.141
Forticel, plain colors	lb.	.63 /	.71
Reprocessed blacks	lb.	.51 /	.58
Lumarith molding cmpds., Group I	lb.	.50 /	.59
Group II	lb.	.46 /	.55
Group III	lb.	.36 /	.45
Sheeting, extruded, non-stock			
Clear	M. sq. in.	.14 /	1.89
Colors	M. sq. in.	.16 /	2.07
Stock, clear	M. sq. in.	.14 /	1.62
Colors	M. sq. in.	.16 /	1.62
Cast, rolls			
Matte	M. sq. in.	.179 /	.648
Tinted	M. sq. in.	.239 /	.708
Sheets, clear	M. sq. in.	.141 /	1.52
Matte	M. sq. in.	.203 /	.788
Tinted	M. sq. in.	.255 /	1.72
Hercocel A, extrusion & injection	lb.	.50 /	.65
Injection, std. colors	lb.	.46 /	.61
Special colors	lb.	.42 /	.45
Tenite Acetate, Group 1	lb.	.50 /	.59
Group 2	lb.	.46 /	.55
Group 3	lb.	.41 /	.51
Group 4	lb.	.38 /	.49
Group 5	lb.	.65 /	.75
Cellulose acetate butyrate:			
Tenite butyrate	lb.	.62 /	.71
A pearls	lb.	.72 /	.81
Blacks, reprocessed	lb.	.50 /	.58
Ethyl cellulose:			
Dyeform 720, 721	lb.	1.29 /	1.52
Ethocel P. G.	lb.	.72 /	.80
Bulk, reg.	lb.	.66 /	.81
Std., 7 cps.	lb.	.71 /	.86
Hercocel E	lb.	.72 /	.88

Epoxy

Araldite 502, 6010, 6020	lb.	.80 /	.995
504	lb.	.77 /	.965
551, 6060	lb.	.75 /	.95
6030, 6040	lb.	.885 /	.995
Bakelite ERL series	lb.	.80 /	.995
Epocast 2, 3, 5	lb.	1.33 /	1.77
4-B-2, 4-B, 4-C, 4-C-T, 4-D, Paste	lb.	1.15 /	1.55
Epon 562	lb.	1.52 /	1.77
815	lb.	.80 /	.99
820, 828	lb.	.80 /	.97
834	lb.	.855 /	1.00
864	lb.	.91 /	1.06
864-C-75	lb.	.73 /	.85
1001	lb.	.615 /	.85
1004	lb.	.595 /	.6025
1007	lb.	.605 /	.6125
1009	lb.	.69 /	.6975
Furane CN-502	lb.	1.33 /	1.77
Jet-Kote (with cat.)	gal.	7.50 /	10.00
Maraset 602, 610, 610V, 612B, 613, 648	lb.	1.25 /	1.70
604A, 607	lb.	1.17 /	1.40
608	lb.	1.17 /	1.65
614A, 631A, 618A, 640	lb.	1.32 /	1.77
645	lb.	1.15 /	1.70
Rezolins A & B	lb.	1.29 /	1.74
Toolplastik packages:			
L-900, L-930	lb.	1.59 /	2.29
L-902	lb.	1.69 /	1.84
L-904	lb.	1.54 /	2.19
L-910	lb.	1.94 /	2.34
L-914	lb.	1.83 /	2.19
L-931	lb.	1.75 /	1.99
L-940	lb	2.05 /	2.29

Fluorocarbon

Bakelite FGBB-33789, FGEB-34790, FXMA-50590, FXMB-50344	lb.	$9.00	/ $10.00
FGEB-32788, FXMB-50090	lb.	12.00	/ 14.00
FYTD	lb.	11.00	/ 13.00
FYTH, FYTS	lb.	8.50	/ 9.50
Kel-F Grade 270, 300			
High density	lb.	9.00	/ 10.00
Low density	lb.	8.50	/ 9.50
Grade 300-P25	lb.	10.00	/ 11.00
Polyfluoron, high density crystals & pellets	lb.	9.00	/ 9.50
Colors	lb.	9.50	/ 10.00
Low density powder	lb.	8.50	/ 9.00
Dispersion grade	lb.	10.50	/ 11.00
Teflon 1	lb.	4.50	/ 5.55
5	lb.	4.75	/ 5.80
6	lb.	7.45	/ 8.00
30 aqueous dispersion	lb.	5.60	/ 6.85

Melamines

Fiberite 2015 (black & pastels)	lb.	.57	/ .62
Pelleted	lb.	.61	/ .66
Cymel 402	lb.	.51	/ .53
404R, 404T	lb.	.85	/ .95
405	lb.	.45	/ .52
428	lb.	.48	/ .55
430	lb.	.465	/ .535
440	lb.	1.10	
480	lb.	.265	/ .315
1077, 1079	lb.	.45	/ .75
Ungranulated	lb.	.43	/ .73
1500	lb.	.42	/ .55
1502	lb.	.45	/ .58
3020	lb.	.57	/ .72
3024-A	lb.	.67	
3135	lb.	.85	/ 1.05
3136	lb.	1.05	/ 1.15
P-592, -592-A	lb.	.65	/ .75
Plaskon	lb.	.44	/ .75

Phenolic

91-LD	lb.	1.50	/ 2.50
Admirez PL-50	lb.	.215	
UP-11	lb.	.2325	
Bakelite general purpose	lb.	.187	/ .3525
BMG-5000	lb.	.19	/ .30
Colors	lb.	.2375/	.435
Chem. resist.	lb.	.23	/ .40
Electrical Insul.	lb.	.2725/	.4125
Heat resist.	lb.	.19	/ .35
Impact resist.	lb.	.24	/ .4025
Barrett foundry resins, liquid	lb.	.2125/	.2425
Powdered	lb.	.27	/ .355
Insulation resins	lb.	.15	/ .175
Molding resin 313, 314, 317	lb.	.27	/ .285
316	lb.	.295	/ .31
1502, -3, -4, -5, R-110R	lb.	.25	/ .265
R-114	lb.	.285	/ .30
Corfoam 107, 114	lb.	.55	/ .82
Cyacor 151	lb.	.215	/ .235
191	lb.	.13	/ .16
Durez, heat resist.	lb.	.19	/ .245
Impact resist.	lb.	.24	/ .63
Insulation	lb.	.21	/ .305
Non-Bleed	lb.	.19	/ .195
Special	lb.	.19	/ .665
Std.	lb.	.19	/ .245
Durite GP	lb.	.195	/ .24
HR	lb.	.191	/ .3025
IM	lb.	.24	/ .415
SG	lb.	.195	/ .3575
Dyform	lb.	1.10	/ 1.35
Fiberite 1078	lb.	.42	/ .43
1087, 1165, 1270, 1271, 1330, 1332, 1347, FM 1132, FM 3510	lb.	.39	/ .395
1153	lb.	.455	/ .46
1167	lb.	.3875/	.3925
1340	lb.	.4275/	.4325
1346	lb.	.44	/ .4475
4010	lb.	.68	
4020	lb.	.815	/ .82
FM 926	lb.	.43	/ .435
927	lb.	.41	/ .415
1914	lb.	.375	/ .38
1957	lb.	.445	/ .45
1996	lb.	.375	/ .38
10365	lb.	.5225/	.5275
11547	lb.	1.05	/ 1.06
11678	lb.	.52	/ .525
14111	lb.	.415	/ .42
17067	lb.	.851	/ .82
17610	lb.	1.05	/ 1.06
Fiberite 1078	lb.	.425	/ .435
1087, 1165, 1270, 1271, 1330, 1332, 1347, 1389, FM-1132, FM-3510, FM-3515	lb.	.395	/ .40
1153 (red only)	lb.	.46	/ .465
1167	lb.	.3925/	.3975
1333, FM-10365, FM-11678	lb.	.67	/ .675
1346, FM-927	lb.	.415	/ .42
1346 (red only)	lb.	.445	/ .452
4030-190	lb.	$0.78	/ $0.81
4031	lb.	.625	/ .63
FM-926	lb.	.435	/ .44
FM-1132 (pellets), FM-14111	lb.	.42	/ .425
FM-1914, FM-1996	lb.	.38	/ .385
FM-11547, FM-17610	lb.	1.07	/ 1.08
FM-11679	lb.	1.29	/ 1.30
FM-17067	lb.	.83	/ .835
G-E molding powders:			
12401	lb.	.31	/ .41
13408, 12486	lb.	.205	/ .215
12410, 12420	lb.	1.50	/ 1.60
12432	lb.	.405	/ .505
12433	lb.	.565	/ .665
12435	lb.	.25	/ .35
12439-A, 12466	lb.	.265	/ .365
12444	lb.	.435	/ .535
12463	lb.	.415	/ .515
12467	lb.	.51	/ .61
12487, 12489, 12884, 12887	lb.	.365	/ .465
12491, 12493, 12853, 12900, 12901, 12902, 12920, 12921	lb.	.21	/ .31
12494	lb.	.385	/ .485
12808	lb.	.50	/ .60
12809	lb.	.66	/ .76
12871-A	lb.	.22	/ .32
12824	lb.	.505	/ .605
12841, 12906	lb.	.255	/ .355
Loven LHR-401, -403	lb.	.225	/ .23
-407, -409	lb.	.60	/ 1.00
-408	lb.	.25	/ .255
LI-201	lb.	.39	/ .40
-207	lb.	.475	/ .48
-209	lb.	.60	/ 1.00
-212	lb.	.425	/ .43
LM-110, -119	lb.	.19	/ .195
-101	lb.	.24	/ .245
-116	lb.	.255	/ .26
-117	lb.	.225	/ .23
-118	lb.	.1975/	.2025
LMI-301	lb.	.2525/	.2575
-303	lb.	.345	/ .35
-304	lb.	.60	/ 1.00
-307	lb.	.3075/	.3125
LMM-801, -803	lb.	.2125/	.2175
-804, -811	lb.	.245	/ .25
-807	lb.	.215	/ .22
Marblette 76, 77	lb.	.50	/ .60
Foam resin 1076	lb.	.50	/ .60
Plenco foundry resins	lb.	.27	/ .35
Molding cmpds. gen. purpose	lb.	.185	/ .235
Heat resist.	lb.	.19	/ .24
Improved Impact	lb.	.225	/ .28
Min. bleed	lb.	.185	/ .195
Radio & TV	lb.	.20	/ .215
Stock	lb.	.205	/ .34
Reilly general purpose	lb.	.195	/ .20
Heat & impact resist.	lb.	.20	/ .205
Resinox molding compounds:			
Gen. purpose & heat resist	lb.	.205	/ .215
Impact	lb.	.255	/ .3225
Low elec. loss	lb.	.31	/ .365
Special grade	lb.	.215	/ .255
Rogers phenolic molding compounds:			
RX 425	lb.	.29	/ .295
Special colors	lb.	.34	/ .405
RX 428	lb.	.355	/ .36
Special colors	lb.	.42	/ .465
RX 429	lb.	.365	/ .37
Special colors	lb.	.395	/ .48
RX 431	lb.	.4125/	.4175
Special colors	lb.	.455	/ .55
RX 438	lb.	.4675/	.4725
RX 441, 455	lb.	.32	/ .325
RX 442	lb.	.3475/	.3525
RX 447	lb.	.5025/	.51
RX 448	lb.	.355	/ .36
RX 458	lb.	.38	/ .385
RX 469	lb.	.365	/ .37
RX 470, 480	lb.	.40	/ .405
RX 478, 488	lb.	.415	/ .43
RX 525, 545	lb.	.29	/ .295
RX 530	lb.	.4125/	.4175
Special colors	lb.	.42	/ .475
RX 547	lb.	.37	0 .375
RX 625	lb.	.395	/ .40
RX 628	lb.	.455	/ .46
Schenectady shell mold resins	lb.	.26	/ .28
Synvar molding compounds, PM series	lb.	.205	/ .2625
Synvaren 640	lb.	.30	/ .335
920	lb.	.21	/ .245
935	lb.	.195	/ .23
9203, 9203A	lb.	.173	/ .208
Synvaren liquid industrial resins:			
675	lb.	.29	/ .325
920	lb.	.21	/ .245
CP-66	lb.	.19	/ .225
PBL-2	lb.	.33	/ .365
PBL-218S	lb.	.27	/ .305
Synvarite GW-1000	lb.	.34	/ .36
GW-1080, PBL-F, PBL-718	lb.	.37	/ .39
GW-2400	lb.	.375	/ .395
PBL-100	lb.	.31	/ .33
PBL-108FF	lb.	.38	/ .40
PBL-210, PBL-3301	lb.	.36	/ .38
PBL-410	lb.	.33	/ .35
PBL-3311	lb.	.35	/ .37
PNL-12HL/11, PNL-156HL/24	lb.	$0.3025/	$0.3225
PNL-159H, PNL-169H	lb.	.29	/ .31
PNL-169PD, PNL-179PD	lb.	.28	/ .30
PNL-355PD	lb.	.315	/ .335
PNL-1279HL	lb.	.2875/	.3075
PT	lb.	.32	/ .34
Toolplastik No. 8000	lb.	.48	/ .72

Polyamide

Fiberfil Nylon G, natural	lb.	1.70	/ 1.90
Standard colors	lb.	1.80	/ 2.20
G.M.I. Polyamide 115	lb.	.64	/ .77
Nylatron G, GS	lb.	1.75	/ 2.00
Spencer Nylon 400, 401, 402	lb.	1.33	/ 1.50
60, 602	lb.	1.48	/ 1.65
601	lb.	1.95	/ 2.10
603, 604	lb.	1.83	/ 2.00
Versamid 115	lb.	.66	/ .89
Zytel molding powder	lb.	1.435	/ 1.60

Polyesters

Acme 1-501	lb.	.82	/ .93
1-501A	lb.	.87	/ .98
1-503	lb.	2.75	/ 3.50
1-510	lb.	.89	/ 1.00
Atlac 363E-02Z, -12Z	lb.	.66	/ .69
-32Z	lb.	.68	/ .71
382E	lb.	.57	/ .60
FP	lb.	.66	/ .69
Bakelite Polyester resins	lb.	.35	/ .75
Celanese polyesters:			
CEL-101, Marcothix 1, 3	lb.	.50	/ .565
Marcothix 5, 7, 8	lb.	.46	/ .525
MR-28C, -28V, -37C, -37CX	lb.	.33	/ .395
MR-28CS	lb.	.35	/ .415
MR-28H, -41R	lb.	.36	/ .425
MR-28R, -36R	lb.	.34	/ .405
MR-28RL, -37RL	lb.	.355	/ .42
MR-30C	lb.	.44	/ .505
MR-31C, -31V	lb.	.37	/ .435
MR-33C	lb.	.53	/ .595
MR-40R	lb.	.38	/ .445
Diall 50-01	lb.	2.90	/ 3.00
50-51	lb.	3.25	/ 3.50
50-52	lb.	3.50	
51-01	lb.	.87	/ .98
52-01	lb.	2.25	/ 2.50
52-20-30	lb.	1.50	
Diall 50-01, 50-51, 50-52	lb.	2.75	/ 3.50
51-01	lb.	.87	/ .98
52-01	lb.	1.95	/ 2.50
52-20-30	lb.	1.30	/ 1.50
Fibercore 1000, 2000	lb.	.50	/ .65
3000	lb.	.55	/ .70
G-E polyesters			
AR 401	lb.	.35	/ .365
AR 403, 480	lb.	.34	/ .355
AR 403 LS, 480 LS	lb.	.355	/ .37
AR 493	lb.	.40	/ .415
AR 499	lb.	.435	/ .45
AR 501	lb.	.455	/ 47
Hetron	lb.	.43	/ .485
IC-312, -400, -514, -548, -625, -730, -800	lb.	.35	/ .385
-312-2	lb.	.365	/ .38
-336, -382, -706	lb.	.37	/ .385
-401	lb.	.44	/ .455
-420	lb.	.355	/ .37
-433	lb.	.38	/ .395
-636, -670	lb.	.48	/ .495
-638, -689	lb.	.55	/ .565
-670-2	lb.	.50	/ .515
-671	lb.	.405	/ .42
Filled resins	lb.	.255	/ .54
Laminac 4110	lb.	.33	/ .345
4111	lb.	.45	/ .465
4116	lb.	.33	/ .345
4120	lb.	.39	/ .405
4123, 4128	lb.	.34	/ .355
4134	lb.	.46	/ .475
4146	lb.	.43	/ .445
4192	lb.	.355	/ .37
4202	lb.	.55	/ .565
Mylar, rolls, types A & C	lb.	2.50	/ 4.80
Type D	lb.	3.00	/ 3.30
Sheets, type A	M. sq. in.	.09	/ 1.11
Type C	M. sq. in.	.09	/ .15
Type D	M. sq. in.	.53	/ 1.34
Plaskon 911, 920	lb.	.55	/ .665
941, 942, 951, 9411	lb.	.35	/ .468
943	lb.	.41	/ .525
9404	lb.	.365	/ .48
9406	lb.	.355	/ .465
9500, 9510, 9511	lb.	.35	/ .465
9600	lb.	.44	/ .555
Polycast 2	sq. ft.	1.89	/ 5.18
3	sq. ft.	1.08	/ 18.00
6	sq. ft.	.66	/ 3.10
7	sq. ft.	.72	/ 7.18
CR-39	sq. ft.	1.25	/ 20.00
Pre-Imp	lb.	.68	/ .85
Thermaflow 100, 200, 300	lb.	.48	/ .82
400, 500	lb.	.52	/ .87
1,000, 2,300	lb.	.34	/ .55
2,400	lb.	.36	/ .58
Vibrin 114, 117, 152, 154	lb.	.34	
115A	lb.	.38	
121	lb.	.46	
135	lb.	3.00	
142	lb.	.50	

151	lb.	$0.35	
152LS-4	lb.	.355	
153	lb.	.40	
X-1633-A	lb.	.49	
X-1636-W	lb.	.585	

Polyethylene

A-C No. 6, 617	lb.	.30 /	.37
No. 6A, 7, 617A	lb.	.35 /	.42
No. 615, G-201	lb.	.38 /	.45
No. 629	lb.	.40 /	.47
No. 729	lb.	.45 /	.52
Alathon	lb.	.41 /	.505
Bakelite DE Series	lb.	.43 /	.725
DYGT	lb.	.54 /	.69
DYLT, DYNF, DYNH	lb.	.41 /	.59
DYNJ	lb.	.44 /	.62
DYNK	lb.	.45 /	.63
Catalin 15-5	lb.	.41 /	.59
Celanese polyethylene sheeting:			
Extruded rolls, 44 in. wide	lb.	.56 /	1.12
Sheets, 44 x 60 in.	sheet	.83 /	8.76
Petrothene 100, 110, 200, 201, 202, 203, 210, 211, 213, 301, 312, 322	lb.	.41 /	.51
310, 320	lb.	.45 /	.55
310-BK-3, 320-BK-3, 320-BK-½, 320 colors	lb.	.53 /	.63
311, 321	lb.	.43 /	.53
311-BK-3, 312-BK-3, 322-BK-3 322-BN-1	lb	.375 /	.48
311-BK-½, 321-BK-3, 321-BK-½, 321-BN-1	lb.	.46 /	.56
321 colors	lb.	.50 /	.60
560	lb.	.38 /	.48
Poly-Eth 1007, 1008.5, 1408.5, 2006, 2007, 2215, 2236, 2256, 2405, 2425, 2455	lb.	.41 /	.55
3215, 5005	lb.	.375 /	.515
3405	lb.	.38 /	.52
4005, 4225	lb.	.43 /	.57
4202, 5003, 5202	lb.	.53 /	.68
Hi-D 1504, 1506, 2504	lb.	.47 /	.61
Reynolon 1000, P series	lb.	.60 /	.80
Tenite Group 1	lb.	.41 /	.45
Group 2	lb.	.43 /	.47
Group 3	lb.	.46 /	.50
Group 4	lb.	.39 /	.43
Group 5, 6	lb.	.50 /	.72
Group 7	lb.	.60 /	.82
Group 8	lb.	.70 /	.92

Silicone

Bakelite GMGA-5001, -5002	lb.	2.75 /	3.10
5003	lb.	4.00 /	4.35
5004	lb.	5.40 /	5.75

Styrenes

Ampacet, crystal	lb.	.315 /	.335
Colors, std.	lb.	.345 /	.365
Special	lb.	.345 /	.75
Pearl	lb.	.41 /	.75
Phosphorescent	lb.	.695 /	1.00
Tinsel	lb.	.41 /	.67
Confetti	lb.	.51 /	.70
Bakelite BMC series, nat.	lb.	.45 /	.685
Colors	lb.	.50 /	.735
BMS, SMD series, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	.52
RMD series, nat.	lb.	.45 /	.685
Colors	lb.	.50 /	.735
TGD series	lb.	.33 /	.35
Colors, std.	lb.	.36 /	.38
Special	lb.	.36 /	1.00
TMD series	lb.	.33 /	.40
Colors, std.	lb.	.36 /	.43
Special	lb.	.36 /	1.00
Catalin, high impact, natural	lb.	.325 /	.355
Colors, std.	lb.	.355 /	.385
Special	lb.	.36 /	1.00
Medium impact, natural	lb.	.325 /	.355
Colors, std.	lb.	.355 /	.385
Special	lb.	.355 /	1.00
Regular grade, crystal	lb.	.305 /	.325
Colors, std.	lb.	.345 /	.365
Special	lb.	.345 /	1.00
Utility black	lb.	.18 /	.235
Cycolac compounds:			
Natural powders	lb.	.58 /	.66
Natural & std. color pellets	lb.	.65 /	.73
Darex Copolymer 3	lb.	.47 /	.67
43G	lb.	.39 /	.58
X34	lb.	.42 /	.61
Latices 3L	lb.	.415 /	.56
610L	lb.	.30 /	.46
3020	lb.	.32 /	.47
Dow Latex, polystyrene	lb.	.30 /	.46
Latices, styrene/ Resins PS-2&3	lb.	.25 /	.35
butadiene	lb.	.30 /	.46
Dylite, expandable beads	lb.	.50 /	.60
Fiberfil Styrene G, natural	lb.	.55 /	1.00
Standard colors	lb.	.65 /	2.00
Koppers, Fibertuff	lb.	$0.55 /	$1.505
MC-185 series	lb.	.33 /	.355
-300 series	lb.	.33 /	1.005
-400 series	lb.	.355 /	1.005
Regular, crystal	lb.	.295 /	.315
Colors, std.	lb.	.335 /	.355
Special	lb.	.335 /	1.005
Pearl	lb.	.41 /	1.005
Phosphorescent	lb.	.695 /	2.005
Kralastic, std. colors	lb.	.50 /	1.10
Lustrex Hi-Flow 55, crystals	lb.	.295 /	.31
Hi-Test 88, std.	lb.	.36 /	.38
Special colors	lb.	.36 /	1.00
L, crystals	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
LHA, std.	lb.	.355 /	.375
Special	lb.	.355 /	1.00
Utility black, gen. purpose	lb.	.18 /	.185
High impact	lb.	.235 /	.24
Medium impact	lb.	.19 /	.195
Marbon resins	lb.	.39 /	.46
Plio-Tuf C75, R100	lb.	.37 /	.45
G85	lb.	.52 /	.59
P100, std. colors	lb.	.41 /	.45
Polycast 4	sq. ft.	2.56 /	11.07
Styron 475, natural	lb.	.33 /	.35
Colors, std.	lb.	.36 /	.38
Special	lb.	.36 /	1.00
Sheets, std.	lb.	.55 /	.60
Special	lb.	.55 /	.62
480, natural black	lb.	.38 /	.40
Colors, std.	lb.	.41 /	.43
Special	lb.	.41 /	1.00
647, crystal	lb.	.305 /	.32
Colors, special	lb.	.345 /	1.34
66, 688, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
700, crystal	lb.	.295 /	.31
Colors, std.	lb.	.335 /	.35
Special	lb.	.335 /	1.00
777 colors, std.	lb.	.355 /	.375
Special	lb.	.355 /	1.00

Urea

Admirez Foundry Resins, SP-30	lb.	.27	
UP-50	lb.	.105	
Beetle C-4980 Brown	lb.	.1875/	.30
No fines granulation	lb.	.2075/	.32
T-298 Black	lb.	.1875/	.30
MUP series, powder	lb.	.30 /	.49
Special colors	lb.	.30 /	.59
Granules	lb.	.33 /	.52
Special colors	lb.	.33 /	.62
Plaskon molding cmpds.:			
Black & Brown	lb.	.1875/	.30
Other colors	lb.	.30 /	.62
Foundry resins, liquid	lb.	.10 /	.13
Powdered	lb.	.2325/	.2525
Sylplast molding cmpds., granules	lb.	.33	
Powder	lb.	.30	

Vinyls

Bakelite QG-5909	lb.	.35 /	.585
QG-5921	lb.	.41 /	.645
5924	lb.	.43 /	.665
QYNA, QYSM, QYSQ	lb.	.27 /	.47
QYNV	lb.	.30 /	.50
QYSJ	lb.	.28 /	.48
VG-1914, 1918	lb.	.37 /	.056
1985	lb.	.35 /	.585
5507	lb.	.31 /	.545
5544	lb.	.405 /	.64
5911	lb.	.315 /	.55
5980	lb.	.32 /	.555
7734	lb.	.28 /	.515
9031	lb.	.265 /	.50
9530	lb.	.275 /	.51
9960, 9970, 9980	lb.	.335 /	.57
VAGH	lb.	.55 /	.75
VMCH	lb.	.41 /	.61
VYDR, VYNW	lb.	.27 /	.47
VYHH	lb.	.32 /	.52
VYLF	lb.	.36 /	.56
VYNS	lb.	.44 /	.64
VYNV	lb.	.32 /	.52
Blacar No. BW-60	lb.	.315 /	.385
NEMA colors	lb.	.355 /	.425
No. BW-80	lb.	.405 /	.455
NEMA colors	lb.	.445 /	.495
No. PC white, ivory, black	lb.	.285 /	.335
Other colors	lb.	.325 /	.375
Darex Everplex A (wet wt.)	lb.	.21 /	.39
B (wet wt.)	lb.	.22 /	.40
G (wet wt.)	lb.	.21 /	.39
Copolymer Y (wet wt.)	lb.	.245 /	.28
PVA Emulsions (wet wt.)	lb.	.19 /	.355
Diamond PVC-45, -50	lb.	.27 /	.33
Dow PVC-100, -111	lb.	.38 /	.57
Exon 402A, 500, 905, 915, 925	lb.	.31 /	.51
450, 468R, 480	lb.	.35 /	.55
461	lb.	9.75	
468	lb.	.33 /	.53
470	lb.	.55	
471	lb.	.50	
654	lb.	.34 /	.54
Formvar	lb.	.865 /	1.03
Gelva emulsions	lb.	.19 /	.205
Granules	lb.	.4175/	.6175
Geon 101, 101EP, 103EP, 202	lb.	$0.27 /	$0.45
121	lb.	.30 /	.48
126	lb.	.28 /	.46
400X110	lb.	.41 /	.59
404HI	lb.	.37 /	.55
409, 426, 427, 428	lb.	.32 /	.50
503H (polyblend)	lb.	.425 /	.525
2042, 2046	lb.	.315 /	.55
Colors	lb.	.365 /	.60
6373	lb.	.345 /	.58
Colors	lb.	.395 /	.63
6461	lb.	.325 /	.56
Colors	lb.	.375 /	.61
8372	lb.	.33 /	.565
Colors	lb.	.38 /	.615
8539, 8726	lb.	.33 /	.565
Colors	lb.	.35 /	.585
8590, 8591, 8592, 8593, 8594, 8595	lb.	2.00 /	2.75
8600	lb.	.275 /	.51
Colors	lb.	.325 /	.56
8620	lb.	.27 /	.505
Colors	lb.	.32 /	.555
8630	lb.	.425 /	.66
Colors	lb.	.475 /	.71
8640	lb.	.35 /	.585
8650	lb.	.32 /	.555
8677	lb.	.435 /	.67
8700A, 8750	lb.	.425 /	.66
Colors	lb.	.455 /	.69
8720	lb.	.605 /	.84
8737	lb.	.33 /	.565
8740	lb.	.295 /	.53
8749	lb.	.29 /	.525
8800	lb.	.44 /	.675
8801	lb.	.275 /	.51
Colors	lb.	.325 /	.56
8802	lb.	.33 /	.565
Colors	lb.	.38 /	.615
8804	lb.	.29 /	.525
8807	lb.	.45 /	.685
8809	lb.	.37 /	.605
8810	lb.	.275 /	.55
8812, 8813, 8814, 8815	lb.	.315 /	.51
Geon Latex 151, 251	lb.	.26 /	.32
351	lb.	.32 /	.38
352	lb.	.28 /	.34
552, 652	lb.	.37 /	.43
450x167	lb.	.39 /	.45
576	lb.	.365 /	.405
Krene, film	lb.	.505 /	.655
Sheeting	lb.	.49 /	.645
Marvinols:			
NF-1005	lb.	.34 /	.625
NF-1055, 3520	lb.	.275 /	.56
NF-3020	lb.	.41 /	.645
NF-3025	lb.	.38 /	.665
NF-3040	lb.	.3375/	.6225
NF-3045, 3050	lb.	.37 /	.605
NF-3055	lb.	.285 /	.57
NF-3060	lb.	.29 /	.575
NF-3065	lb.	.30 /	.585
NF-3070, 3075, 3080		.265 /	.50
NF-3085, 3090, 3095	lb.	.29 /	.525
NF-3505, 3515	lb.	.36 /	.595
NF-3510	lb.	.34 /	.575
NF-4005	lb.	.44 /	.675
NF-4010, 4015, 4020	lb.	.42 /	.705
NF-5015, 5020	lb.	.40 /	.655
NF-5025	lb.	.33 /	.585
NF-5030	lb.	.29 /	.545
NR-6015	lb.	.39 /	.685
NR-6020	lb.	.39 /	.675
NR-7002, 7045, 7060	lb.	.50 /	.735
VR-10	lb.	.30 /	.47
VR-12, -20, -21, -22, -24, -30	lb.	.29 /	.46
VR-50	lb.	.32 /	.49
Opalon 300, 300FM	lb.	.31 /	.51
410	lb.	.34 /	.54
505	lb.	.35 /	.55
Inj. molding cmpds.	lb.	.29 /	.67
Profile extrusion cmpds.	lb.	.29 /	.72
Wire cmpds.	lb.	.29 /	.67
Plastiflex, std.	lb.	.90 /	1.10
Novelty	lb.	1.15 /	1.50
Pliovic AO (dispersion)	lb.	.30 /	.32
DB80V, DB90V, EDB90V	lb.	.27 /	.29
Latex 300	lb.	.30 /	.35
Reynolon, 4000 series	lb.	1.55 /	2.30
Rolls, 1-mil	sq. yd.	.0625/	.11
Colors	sq. yd.	.0675/	.08
4-mil	sq. yd.	.215 /	.3125
Colors	sq. yd.	.2375/	.255
16-mil	sq. yd.	.81 /	1.19
Colors	sq. yd.	.86 /	.945
Satinflex	lb.	1.15 /	1.50
Vygen 110, 120	lb.	.27 /	.31
1101, 1150	lb.	.425 /	.50
2201	lb.	.48 /	.55

Vinylidine

Dow Latex 744-B	lb.	.26 /	.42
Resin 565	lb.	.39 /	.525
Saran formulation 115, black, nat.	lb.	.39 /	.52
Colors	lb.	.44 /	.69
720 nat.	lb.	.41 /	.54
Colors	lb.	.46 /	.71
747 nat.	lb.	.395 /	.525
761 nat.	lb.	.39 /	.52
Colors	lb.	.44 /	.69

820 nat	lb.	$0.42 /	$0.55
Colors	lb.	.47 /	.60
Latices	lb.	.45 /	.61
Resin F 120	lb.	.58 /	.65
F242	lb.	.64 /	.70

Solvents

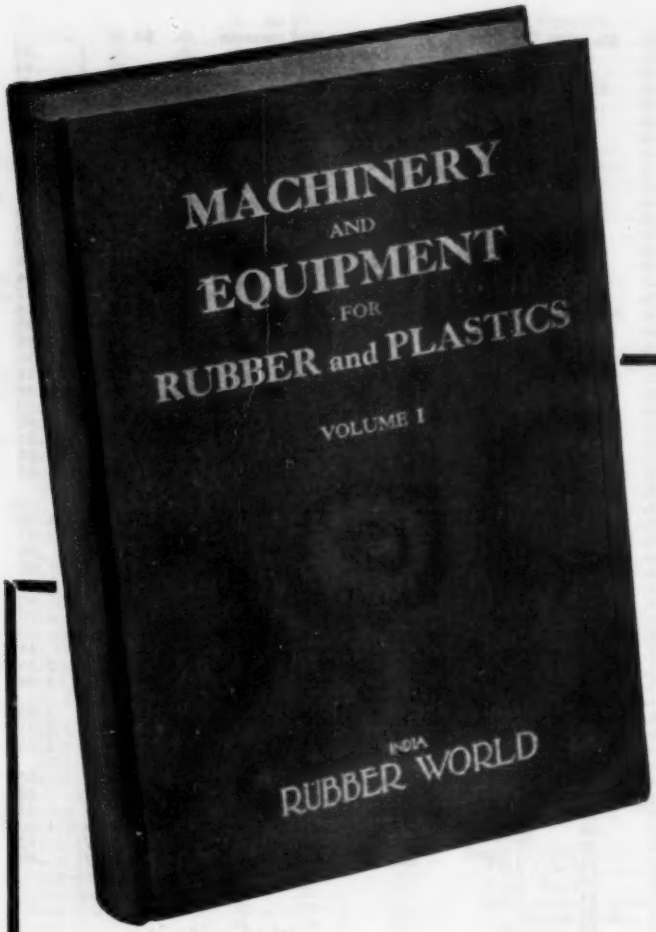
Enjay acetone	lb.	.08 /	.115
Isopropyl acetate	lb.	.11 /	.145
Methylethyl ketone	lb.	.12 /	.155
Secondary butyl acetate	lb.	.1175/	.1525
Butyl alcohol	lb.	.12 /	.155
Petrohol 91%	gal.	.37 /	.60
95%	gal.	.39 /	.62
99%	gal.	.41 /	.64

Stabilizers

Advastab B-13-P, BC-105, XBC-147	lb.	.75 /	.80
BC-12, C-77, E-82, XC-79, XC-143	lb.	.90 /	.95
BC-74, XBC-30	lb.	.70 /	.75
C-21	lb.	1.00 /	1.05
CH-101, CH-201	lb.	.60 /	.65
JCX	lb.	.62 /	.67
L paste, Z-6	lb.	.65 /	.70
SN	lb.	.47 /	.52
T-10, T-52	lb.	1.90 /	1.95
T-17M	lb.	2.95 /	3.00
T-50LT	lb.	3.20 /	3.25
T-7-2, T-671	lb.	2.67 /	2.70
155	lb.	.69 /	.74
XE-98	lb.	.53 /	.58
Argus Mark C	lb.	.88 /	.95
E	lb.	.72 /	.85
M	lb.	.68 /	.74
PL	lb.	.63 /	.69
TT	lb.	.72 /	.86
WS	lb.	.98 /	1.11
X	lb.	2.50 /	2.75
XI	lb.	.87 /	1.01
XV	lb.	.92 /	.99
XX	lb.	.58 /	.65
Barca 10	lb.	.75 /	.80
Baker barium ricinoleate	lb.	.70	
Calcium ricinoleate	lb.	.55	
Zinc vicinoleate	lb.	.60	
Dutch Boy Barinac	lb.	.70	
Calstar	lb.	.37	
Clarite A	lb.	.83	
B	lb.	.68	
CS-137	lb.	1.25	
DS-207	lb.	.55	
Dyphos	lb.	.58 /	.595
50A	lb.	.34	
Dythal	lb.	.395 /	.41
Leadstar	lb.	.39	
Lectro 60	lb.	$0.2525	
Normal lead maleate	lb.	.4475	
Normasal	lb.	.46	
Pearlescent pigment	lb.	1.00	
Plumb-O-Sil-A	lb.	.3075	
-B	lb.	.325 /	.37
-C	lb.	.3475/	.375
Provinite A	lb.	.83	
B	lb.	.68	
Tribase	lb.	.275	
-E	lb.	.2225	
Trimal	lb.	.435	
Ferro 182	lb.	.70 /	.76
200	lb.	1.31 /	1.43
203, 900, 1820	lb.	.88 /	1.00
503	lb.	.28 /	.40
541A	lb.	.80 /	.92
700	lb.	.47 /	.59
703, 1972	lb.	.63 /	.75
823	lb.	2.50 /	2.75
840	lb.	3.25	
903	lb.	.58 /	.70
909	lb.	.91 /	1.01
1203	lb.	1.30 /	1.40
1206	lb.	1.23 /	1.33
1212	lb.	.68 /	.80
1825	lb.	.98 /	1.10
1840	lb.	.73 /	.85
1976	lb.	.45 /	.57
Harshaw 1-V-3	lb.	.43	
1-V-4	lb.	.68	
1-V-7	lb.	.66 /	.71
2-V-4	lb.	.85 /	.90
2-V-7	lb.	1.10 /	1.15
2-V-8	lb.	1.30	
2-V-400	lb.	.80 /	.85
5-V-1	lb.	.41	
5-V-22	lb.	.49	
7-V-1	lb.	.90 /	.95
7-V-2	lb.	.95 /	1.00
7-V-4	lb.	1.18 /	1.23
8-V-1	lb.	1.10 /	1.15
8-V-5	lb.	.80 /	.85
8-V-100	lb.	.84 /	.89
9-V-1	lb.	.76 /	.81
12-V-5	lb.	.75	
22-V-1	lb.	1.28	
24-V-1	lb.	1.28 /	1.33
28-V-2	lb.	1.18	
128-V-5	lb.	.86	
281-V-4	lb.	.90	
Merix AST Concentrate 1001	lb.	.355 /	1.75
Metasap 613-A	lb.	.69	
613-B	lb.	.84	
613-C	lb.	1.06	
621	lb.	.88	
624	lb.	.75	
Cadmium stearate	lb.	1.40 /	1.44
Fused stearates, calcium 602-A	lb.	.25 /	.30
Dibasic lead stearate	lb.	$0.56	
Lead 611	lb.	.32 /	.37
Lead stearate	lb.	.39 /	.44
Nuostable V-1	lb.	.54 /	.59
V-2	lb.	.39 /	.44
V-10	lb.	.70 /	.75
V-20	lb.	1.30 /	1.35
V-21	lb.	1.29 /	1.34
V-30	lb.	.90 /	.95
V-31	lb.	.80 /	.85
V-40	lb.	1.18 /	1.23
V-42	lb.	.65 /	.70
V-43	lb.	.75 /	.80
V-44	lb.	.90 /	.95
V-45	lb.	1.10 /	1.15
V-50	lb.	.49 /	.54
V-60	lb.	.37 /	.42
V-70	lb.	.68 /	.73
V-80	lb.	2.80 /	2.85
V-81	lb.	2.90 /	2.95
Permyl A	lb.	.45 /	.57
Stabelan 110, 120	lb.	.65 /	.75
115, HR paste	lb.	.85 /	.95
E	lb.	1.35 /	1.50
HR-50	lb.	.75 /	.90
HR liquid	lb.	.65 /	.75
Powder	lb.	.95 /	1.05
XL	lb.	.55 /	.65
Staflex QMXA	lb.	.70	
50% in DOP	lb.	.52	
OY	lb.	1.00 /	1.20
Stayrite #10	lb.	.33 /	.37
#15	lb.	.54 /	.57
#20	lb.	.38 /	.42
#22	lb.	1.32 /	1.34
#25	lb.	.36 /	.40
#70, 75, 80, 90	lb.	.69 /	.70
#229	lb.	.47 /	.50
P-10	lb.	.40 /	.44
Thermolite 12	lb.	2.00 /	2.25
13	lb.	3.10 /	3.78
15	lb.	4.13	
17	lb.	2.45 /	2.75
20	lb.	2.95 /	3.25
39	lb.	2.75 /	3.25
91	lb.	3.00	
Vanstay C-73 S	lb.	.63 /	.65
HT	lb.	.90 /	.92
L	lb.	.33 /	.35
LN	lb.	.98 /	1.00
R	lb.	.70 /	.72
Z	lb.	.67 /	.69

Wetting Agents

Advawet X-212	lb.	.50 /	.55
Poly-lube No. 4	gl.	1.45 /	1.94



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